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## SMALL ARMS TRAINING

Volume I, Pamphlet No. 7

### .303-inch Machine Gun

#### Part III.—Fire Control

#### GENERAL

Small Arms Training, Volume I, Pamphlet Number 7, Part III, deals with the various methods of applying machine gun fire. It is written for officers and non-commissioned officers whose duty it will be to direct and control fire, but before studying it they should be thoroughly conversant with Small Arms Training, Volume I, Pamphlets Number 1, Section 2 (Theory of Small Arms Fire) and Number 2 (Application of Fire). A very elementary knowledge of mathematics will assist the reader in grasping the methods of fire control quickly.

#### DEFINITIONS

(See also Small Arms Training, Volume I, Pamphlet Number 7, Part II)

**Angle of distribution.**—The angle between adjacent lines of fire opened up to divide a target wider than the gun frontage into equal parts, the flank guns being laid on the flanks of the target.

**Angle of sight.**—The angle contained between the line of sight and the horizontal plane. The angle is said to be positive (+) when the target is above the horizontal plane through the gun position (Figure 3), and negative (−) when the target is below it (Figure 4).

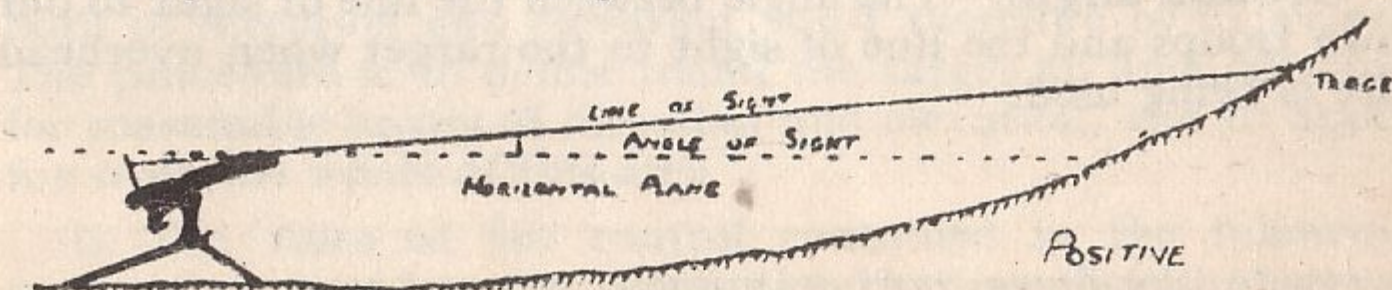
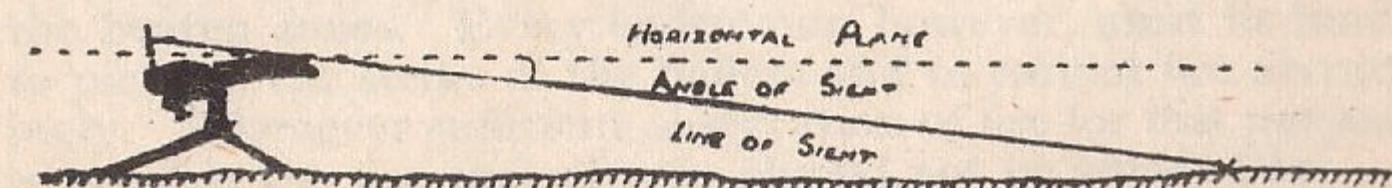


Figure 3



NEGATIVE.

Figure 4



**Crest clearance angle.**—The angle by which the axis of the barrel must be raised above the line of sight to the crest to ensure that all the bullets clear the crest.

**Distribution.**—The opening out of parallel lines of fire.

**Flanking fire.**—Fire applied from a flank across the front of a locality occupied by our own troops, or, if they are advancing, at an angle to their line of advance.

**Fixed line.**—A term denoting that measures have been taken for maintaining elevation and direction in darkness, smoke, etc., to ensure that fire will fall on a pre-arranged area of ground.

**Line of fire.**—The direction of the target from the gun.

**Minimum clearance.**—A term used to denote the minimum height of the centre bullet of the cone above the heads of our own troops for the latter to be safe.

**Overhead fire.**—Fire passing over the heads of our own troops.

**Quadrant angle.**—The angle which the axis of the barrel makes with the horizontal plane.

**Safety angle for flanking fire.**—The minimum lateral angle by which a line of fire must clear our own troops in order to ensure their safety.

**Safety angle for overhead fire.**—The minimum angle which must be included between the axis of the barrel and the line of sight to our own troops to ensure their safety under overhead fire.

**Tangent angle.**—The angle which the axis of the barrel makes with the line of sight.

**Ground angle.**—The angle between the line of sight to our own troops and the line of sight to the target when overhead fire is being used.

## SECTION 23.—GENERAL PRINCIPLES

**1. Introduction.**—The considerations which govern the method of applying machine gun fire are :—

- i. The best fire effect on the whole target.
- ii. Economy of time and ammunition.
- iii. Simplicity and speed.
- iv. Safety of our own troops.

The factor of surprise as applied to fire cannot be over-estimated.

Fire control orders must be framed in such a way that all these requirements are met.

The system of fire control laid down in this pamphlet is worked out on the above basis and should be adhered to. Occasionally the situation may not permit the rules given to be carried out in their entirety. Common sense, and a knowledge of how the rules are arrived at, will enable the best fire effect to be obtained in these circumstances.

**2. Basis of fire control rules.**—i. Fire effect is desirable as soon as fire is opened or immediately after. Observation of machine gun fire is only possible on certain types of ground, and, particularly in European countries, can never be relied upon. The opportunity of correcting fire on to the target by observation of strike will therefore seldom occur.

ii. There is no quick reliable means of determining with precise accuracy the effect of climatic conditions. Errors, both of direction and elevation, must therefore be expected. The procedure is to define round the target an area allowing for reasonable errors of direction and elevation, and to apply fire over the whole of this area.

iii. The rules of fire control contained in the following sections are based on the assumption that insufficient observation of strike will be obtained to deduce the exact position of the beaten zones. Every endeavour, however, must be made to pick up the strike of the bullets and to correct fire accordingly. Whenever sufficient observation of fire for this purpose is possible the fire control rules should not be adhered to.

**3. Direct or indirect fire.**—i. The normal method of engaging a target will be by direct fire, i.e. by laying on the target over the sights. The main asset of direct fire is its



extreme flexibility, which enables a succession of targets over a wide arc to be engaged quickly.

ii. The machine gun is capable of firing indirect, i.e. the gun is laid on an auxiliary aiming mark, with the elevation required to hit the target obtained and placed on the gun by instruments. Indirect fire is employed when it is impossible or inadvisable to occupy a direct fire position, or when shooting from a map.

The main technical advantage of indirect fire is that the necessity for indicating the target to a number of individuals is removed. The laying of the gun is mechanical, and its accuracy is not affected by light or distance.

The disadvantages are the necessity for additional measurements and calculations, and the difficulties of crest clearance owing to the flat trajectory.

iii. Conditions which obstruct the field of view (e.g. bad visibility, fog, smoke screens, etc.) often arise after a position is occupied. Consequently, when direct fire is to be employed, certain arrangements for indirect fire should be made as soon as time permits. The details of these arrangements can be found in section drill—direct fire (Section 17).

iv. The principles and details of fire control set down in this pamphlet apply both to direct and indirect fire. As the methods of fire, and details of fire discipline, are in many instances not the same, direct and indirect fire are treated separately in the remainder of this part.

#### 4. Safety Precautions

On all occasions when the gun and dummy cartridges are used for instructional purposes, the instructor will carry out the following safety precautions:—

- I. Inspect all locks to ensure that the striker does not protrude through the firing pin hole.
- II. Inspect all ammunition to ensure that all cartridges are dummies.

Note (a) When instruction is being given in mechanical subjects, "drill purpose" stores if available will always be used.

(b) When service stores are used sub-paragraph I above does not apply.

#### LESSON 95.—ELEVATION

##### *Instructor's Notes*

##### *Stores:—*

*Gun and tripod, dial sight, range table, blackboard.*

*First ensure that the class understand the forces which act upon the bullet (Small Arms Training, Volume I, Pamphlet Number 1, Section 2).*

*Explain the tangent angle and demonstrate how it is applied to the gun by the tangent sight—show how whenever the gun is laid (direct or indirect) the two components of elevation are the tangent angle and the angle of sight.*

*Demonstrate elevation as applied to the gun with the dial sight (indirect fire), and finally explain the quadrant angle.*

1. When firing direct, elevation is given to the machine gun by setting the tangent sight at the graduation corresponding to the range to the target and directing the line of sight on

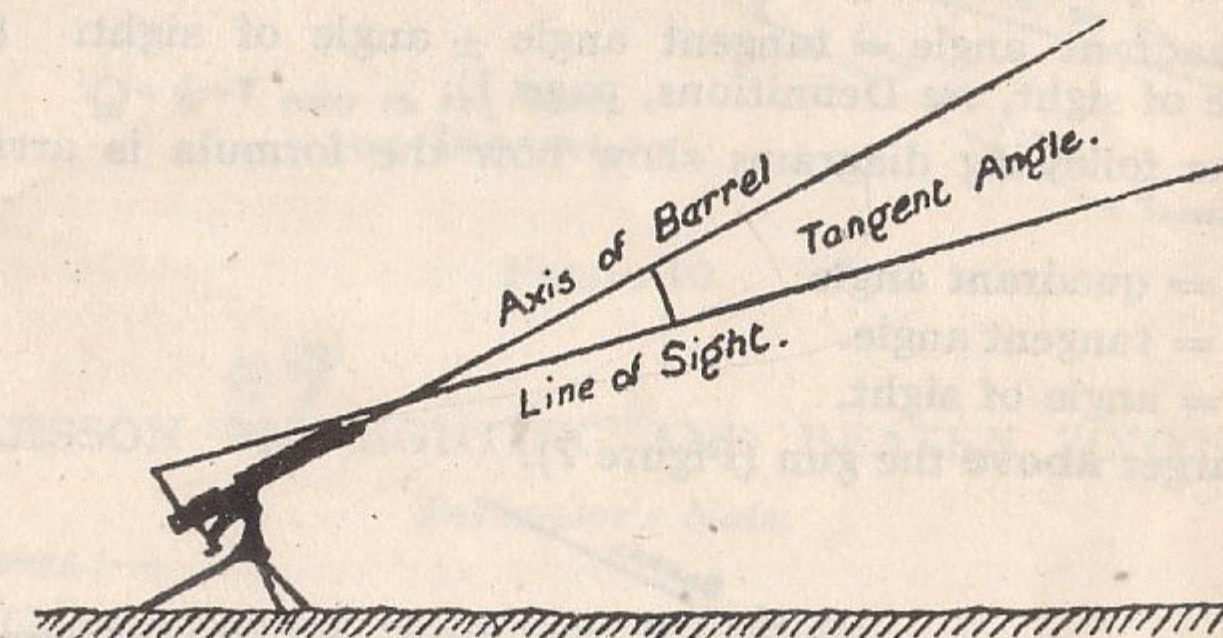


Figure 5

to the point of aim. This process sets the axis of the barrel at an angle above the line of sight (Figure 5). This is the angle of tangent elevation (tangent angle) for the range at which the tangent sight is set.\* Tangent angles for all ranges have been determined and are laid down in the Range Table.

2. When firing indirect elevation or depression is placed on the gun by means of the dial sight in two components:—

- i. The range (tangent angle) on the range drum.
- ii. The angle of sight to the target on the angle of sight drum.

It may sometimes, however, be convenient to the fire controller to be able to express the angle of elevation given

\* Except where the line of sight is abnormally steep; i.e. in mountainous countries. This point is explained in Lesson 96.



to a gun in relation to the horizontal. This angle is known as the quadrant angle, and is the angle between the axis of the barrel and the horizontal (Figure 6).

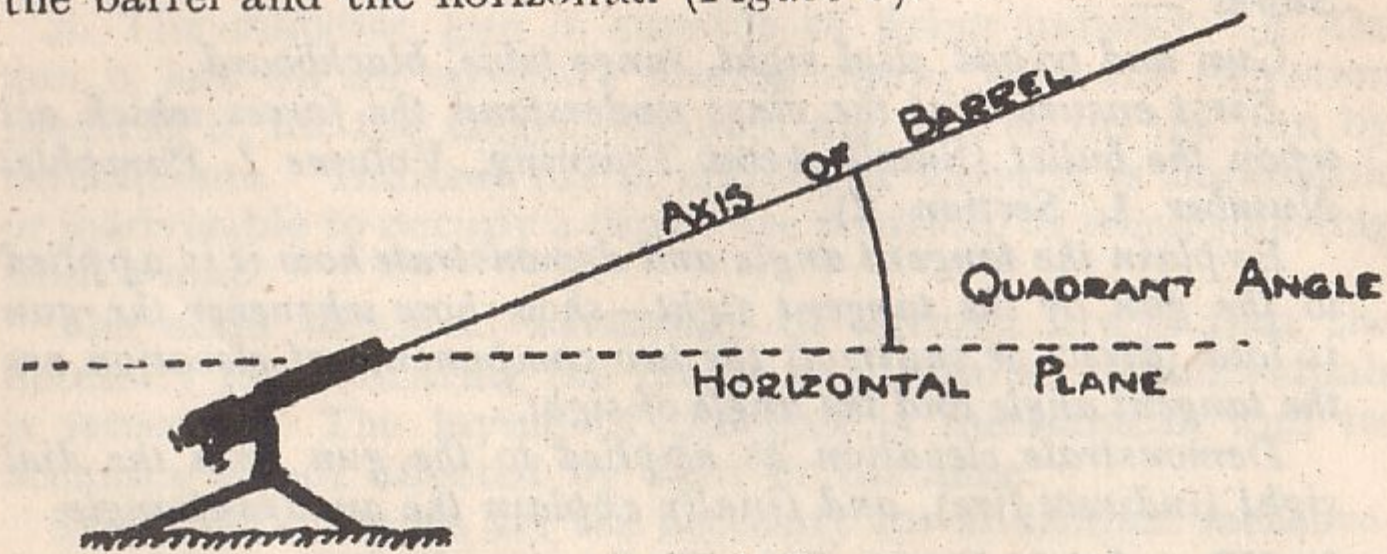


Figure 6

The quadrant angle is calculated from the formula:—

Quadrant angle = tangent angle  $\pm$  angle of sight. (For angle of sight, see Definitions, page 1).

The following diagrams show how the formula is arrived at:—

$Q$  = quadrant angle.

$T$  = tangent angle.

$S$  = angle of sight.

Target **above** the gun (Figure 7).

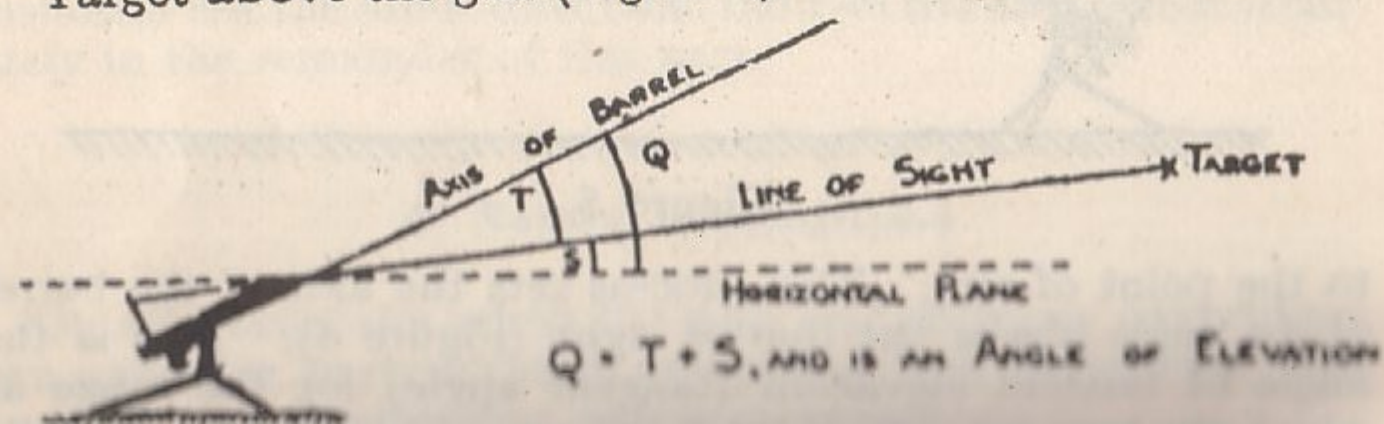


Figure 7

Target **level** with gun (Figure 8).

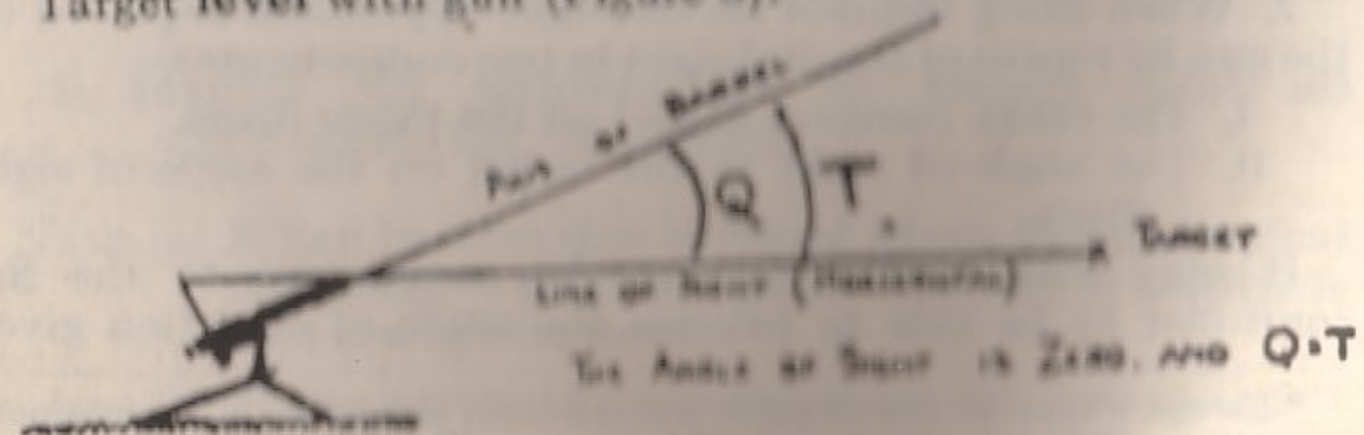


Figure 8

Target **below** gun (Figure 9).

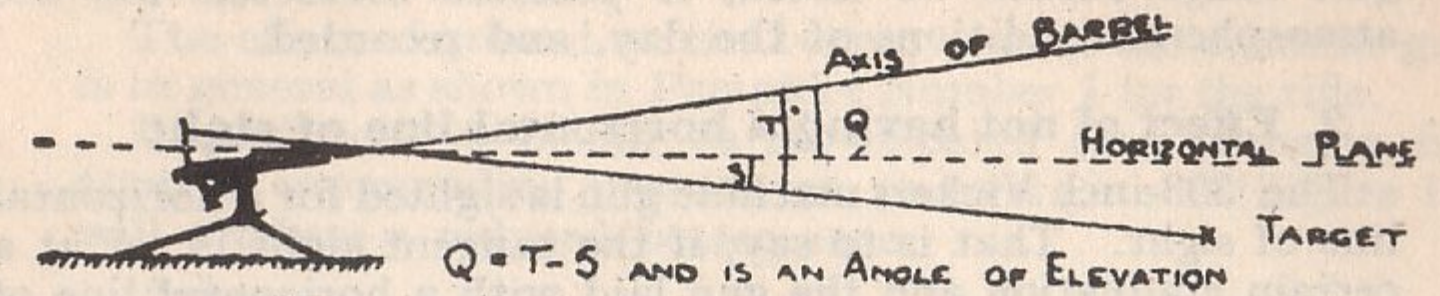


Figure 9

Target **far below** gun (Figure 10).

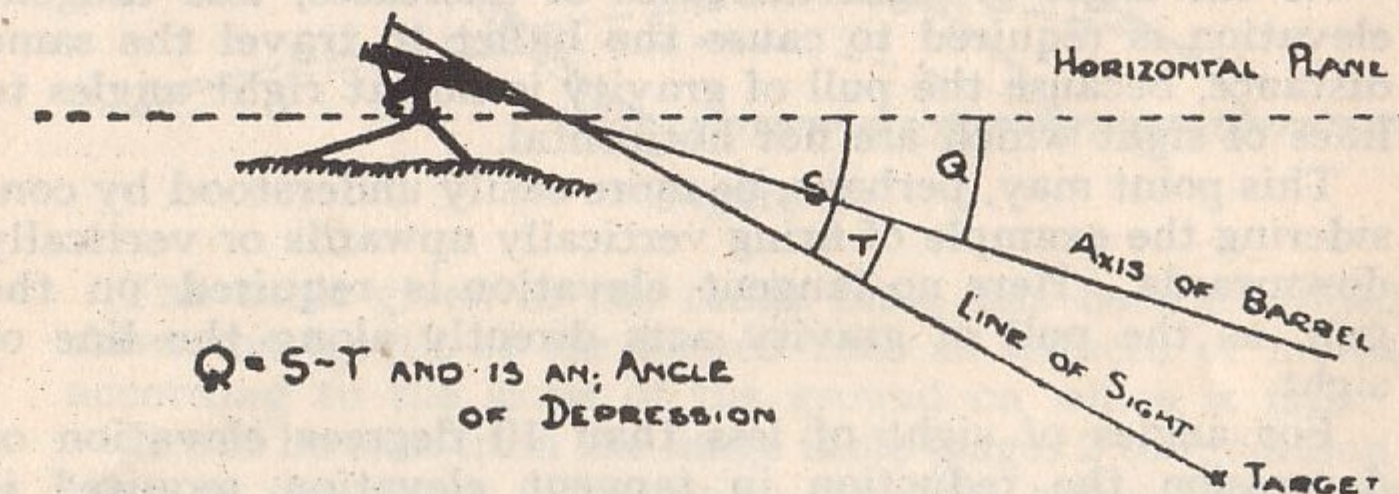


Figure 10

## LESSON 96.—SIGHTING AND BEATEN ZONES

*Instructor's Notes*

*Stores:—*

*Gun and tripod, range table, blackboard.*

*Method of instruction.*

*Explain the normal (i.e. approximately horizontal line of sight) and the abnormal in conjunction with the chart in the Range Table, 1939, page 17 and paragraph 2 below.*

*Explain the beaten zone and how it is affected by ground (Range Table, page 14).*

### EXPLANATION

#### 1. Sighting of machine guns

In common with other small arms, a mean graduation for each range has been adopted, and guns are carefully tested for accuracy before issue. In course of time wear to mountings and barrels, and irregularities in packing, may require individual gun corrections to be made when setting the tangent sight for a particular range.

On all occasions when the gun is firing ball ammunition



and it is possible to determine the range with accuracy, the gun range should be noted, if possible corrected for the atmospheric conditions of the day, and recorded.

## 2. Effect of not having a horizontal line of sight

The .303-inch Vickers machine gun is sighted for a horizontal line of sight. That is to say, if the tangent sight is set at a certain graduation and the gun laid with a horizontal line of sight, a single shot will, in theory, strike the horizontal plane at a distance away from the gun corresponding to the graduation at which the sight is set.

As the angle of sight increases or decreases, less tangent elevation is required to cause the bullet to travel the same distance, because the pull of gravity is not at right angles to lines of sight which are not horizontal.

This point may, perhaps, be more easily understood by considering the example of firing vertically upwards or vertically downwards. Here no tangent elevation is required on the gun, as the pull of gravity acts directly along the line of sight.

For angles of sight of less than 10 degrees elevation or depression the reduction in tangent elevation required is negligible. In mountainous countries, however, it will be necessary to set the sight at a corrected range. A chart from which the corrected range for abnormal angles of sight can be obtained is given in the Range Table, 1939, page 17.

## 3. Beaten zones

The beaten zone of the machine gun has similar characteristics to that obtained in collective rifle fire. The fixed mounting gives greater accuracy and closer grouping. The dimensions of the beaten zones for various ranges have been obtained by experiment, and are laid down in the range table. The rules contained in this pamphlet are based on these dimensions, which vary little for different guns and mountings, and hence can be taken as constant for each range.

As in collective rifle fire, the length of the beaten zone decreases as the range increases. Beyond 2,700 yards the machine gun beaten zone again begins to increase. This is due to minor differences in the velocity of individual bullets.

Its breadth increases up to extreme range.

The fact that it is narrow in comparison to its length calls for great accuracy in direction, and renders the gun peculiarly suited to engage, from a flank, targets with width and little depth.

If, however, the target has depth it may be advisable to engage it by frontal fire, in order that the length of the beaten

zone may be employed to cover the depth of the target as opposed to its width.

The effect of ground on the beaten zone of the machine gun is in general as shown in Pamphlet Number 1 for the rifle.

In addition, it should be remembered that plunging fire from a commanding position on to level ground (Figure 11) will produce a reduced beaten zone.

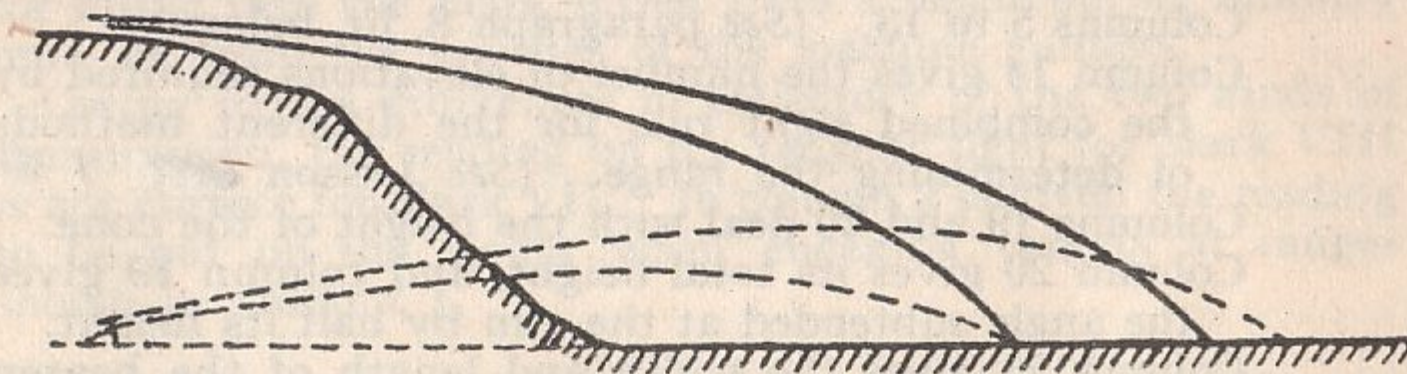


Figure 11

The table given in the range table has been compiled to show the length of the beaten zone as reduced or increased according to the slope of the ground on which it falls.

It will be seen from the range table (pages 2 to 7, column 23) that as the range increases so does the angle of descent of the bullet; consequently each bullet in its descent endangers a smaller area of ground at long ranges than at short ranges.

It follows that as the range, the error in determining the range (see Lesson 98), the area of the beaten zone, and the angle of descent of the bullet increase, the destructive or neutralizing effect of the fire of each machine gun becomes greatly reduced. To compensate for this reduction, a larger number of machine guns should be employed on neutralizing tasks at long ranges.

The greatest width of front which can be effectively engaged at any range is 50 yards per gun.

The length of bursts of machine guns will normally be 25 rounds at all ranges.

## LESSON 97.—RANGE TABLE AND CLIMATIC INFLUENCES

### Instructor's Notes

Stores :—

Range table, blackboard.

Those parts of the range table which are described in this lesson should be explained, and simple exercises in them should be set, until the class is thoroughly familiar with them.



## 1. Pages 2 to 7.

Columns 1 and 26 give the ranges in 50's from 50 to 4,500 yards.

Column 2 gives the tangent angles.

Column 3 gives the lifts for 50 yards, i.e. the angular amount by which each elevation has to be increased so as to add 50 yards to the range.

Columns 5 to 13. (See paragraph 8, iii, below.)

Column 14 gives the number of elevations required by the combined sight rule for the different methods of determining the range. (See Lesson 98.)

Columns 19 and 20 deal with the height of the cone.

Column 20 gives its total height, and column 19 gives the angle subtended at the gun by half its height.

Column 21 gives the width and length of the beaten zone. The figures given are for 90 per cent. of the total shots fired. The stray shots, which produce little fire effect, are therefore not included. The length of beaten zone is that along the line of sight.

Column 22 gives the time of flight at each range.

Column 23 gives the slope of descent of the bullets compared with the line of sight. This figure enables a fire controller to calculate whether his fire can be brought to bear on reverse slopes.

Columns 24 and 25. (See paragraph 8, ii, below.)

Columns 4 and 15 to 18 deal with crest clearance and safety, which will be learnt later.

2. Pages 14 and 15 give the foreshortening effect of a forward slope on the length of the beaten zone, and the lengthening effect of a reverse slope.

The gaps in the bottom left-hand corner of the table are caused by the fact that, at those figures, the reverse slope is steeper than the angle of descent of the bullet, with the result that such slopes are "dead ground" when engaged at those ranges.

3. Page 16 gives the formula to determine the angle of sight (Lesson 118) and the allowance for moving targets (Lesson 106). 108

4. Page 17. The machine gun is sighted for a horizontal angle of sight, and in this sighting is sufficiently accurate for all angles of sight between plus  $10^\circ$  and minus  $10^\circ$ .

If the angle of sight exceeds  $10^\circ$ , allowance must be made in accordance with the chart. If it be imagined that a target is being engaged immediately above or below the gun, i.e. at an angle of sight of  $90^\circ$ , clearly no tangent angle is required

on the sight, no matter what the range. At steep angles of sight, therefore, less elevation is required than for a horizontal angle of sight. See example at the foot of the chart.

5. Pages 18 and 19. This table caters for the possible situation in battle where the supply of Mark VIII ammunition has temporarily failed, but where Mark VII is obtainable for filling into the belts, either from a neighbouring infantry unit, or from the pouches of the machine gunners.

Owing to the differences in trajectory of the two kinds of ammunition, the reading on the tangent sight for Mark VIII is not correct for Mark VII. In column 2 is given the reading to be put on the sights when engaging targets at ranges shown in column 1.

### 6. Graph for calculating quadrant elevation and clearances (The Q.A. graph).

This graph is formed by plotting the path of the centre bullet for quadrant angles, increasing by  $15'$  increments, from depression  $2^\circ$  to elevation  $17^\circ 30'$ .

The red horizontal line marked "O" represents the horizontal line through the gun position. The other red horizontal lines give heights in hundreds of metres above or below the gun position. The intermediate black dotted lines give heights in tens of metres. The equivalent to heights in feet are given down the right edge of the graph.

The vertical lines give the range from the target in hundred yards intervals, the multiples of 1,000 being in red.

The chief use of the graph is to determine the Q.A. for targets at any height above or below the gun.

For example :—

Range to target ... .. 1,900.

Height of target above gun ... .. 70 metres.

Find the point where the horizontal line for plus 70 metres cuts the vertical line for 1,900 yards.

Note the curve which passes through this point. It is the curve for elevation  $5^\circ 15'$ . (The curves for degrees are in red, those for  $30'$  are in thick black, those for  $15'$  and  $45'$  in thin black.)

Elevation  $5^\circ 15'$  is therefore the Q.A. required.

The graph can also be used in connection with crest clearance and the overhead safety of our own troops where the distance of the crest or own troops above or below the gun is found as a height, and not as an angle of sight (e.g. map shoot). The use of the graph for these purposes is dealt with under the lessons concerned.



### 7. V.I. graph

The commonest uses of the V.I. graph are:—

- Knowing the range, to determine the distance or height subtended by a certain angle.
- Knowing the range, to determine the angle subtended by a certain distance or height.

In Fig. 12, if G is the gun, and GA the range, then AB is the distance subtended by AGB at the range GA, and  $A_1B_1$  is the distance subtended by the angle AGB at the range  $GA_1$ .

Similarly, the angle AGB is said to subtend AB and  $A_1B_1$  at the ranges GA and  $GA_1$  respectively.

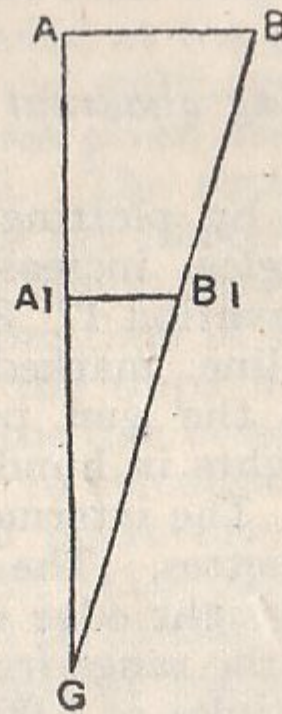


Figure 12

Example :

Angle AGB equals  $4^{\circ} 10'$ .

Range GA equals 3,300 yards.

What is the length of AB?

Find the point where the horizontal line for 3,300 yards meets the diagonal line for  $4^{\circ} 10'$ .

Follow the vertical line through this point down to the scale at the bottom of the graph, and the figure gives the length of AB. It is 240 yards.

### 8. Climatic influences

- The following are the normal conditions for the sighting of small arms:—

Barometric pressure. 30 inches. (Mean sea level.)

Temperature. 60 degrees Fahrenheit.

Still air.

A horizontal line of sight.

### ii. Barometer and temperature.

If the barometer falls below 30 inches, less elevation than is normally required for the distance will be necessary, as the atmosphere, being less dense, offers less resistance to the bullet. It should be noted that the barometer will fall one inch for every 1,000 feet above mean sea level. If the barometer rises above 30 inches, more elevation is required, as the air is denser.

The bullet meets with less resistance in hot weather, when the temperature is high and the air less dense; and greater resistance in cold weather, when the temperature is low. In the former case, therefore, less elevation is required, and in the latter more.

Allowances for barometer and temperature variations are normally small, and are not usually necessary except at great heights or under conditions of extreme heat or cold.

Allowances for one inch rise or fall of barometer and  $10^{\circ}$  rise or fall in temperature will be found opposite each range in columns 24 and 25 of pages 2 to 7 of the range table. It should be noted that for a *fall* in barometer, and a *rise* in temperature, the allowance to be made is subtracted and vice versa.

### iii. Wind.

Winds blowing directly along the line of fire from front to rear will affect the elevation, but here again unless the wind is very strong and the range long, the allowance required is small.

Winds blowing directly at right angles to the line of fire will affect direction, and have considerable effect on the bullet, particularly at long ranges.

Winds blowing from a direction oblique to the line of fire will affect both direction and elevation.

Although where speed is essential it may be necessary to estimate in taps the lateral allowance to be made for a side wind, recourse should be had to the wind table in the range table when time permits.

Having estimated the strength and direction of the wind, the allowance required may be obtained from the range table on pages 2 to 7, columns 5 to 13.

An explanation of the use of the wind table is on page 8 of the range table.

### 9. The meteor telegram

In order to make accurate allowances for climatic influences, meteor telegrams are published periodically in war. They are primarily intended for artillery units, but it may be possible for machine gun units to arrange to be sent copies, or to obtain



the necessary information from neighbouring artillery units. An example with explanatory notes is shown :—

TO					
FROM	Originator's Number		Date	In reply to Number	
Bar	3250	0543	18158	1041	20164
1538	21166	2037	22168	2535	24167
3034	24160	3532	25158	4040	25154

i. "Bar 3250" is the height of the barometer in inches, to two places of decimals, at mean sea-level (M.S.L.). For the purpose of applying corrections this figure must be corrected for the height of the gun position. The rules for applying corrections are: For every metre rise deduct 0.003 inch or for every foot rise deduct 0.001 inch, from the mean sea-level reading.

ii. The first two figures in each subsequent four-figure group are the time of flight.

iii. The last two figures in each subsequent four-figure group give the air temperature in degrees Fahrenheit.

iv. Each five-figure group relates to the preceding group of four figures.

v. The first two figures in each five-figure group give the velocity of the equivalent constant wind in feet per second. To convert feet per second into miles per hour, multiply by two and divide by three. Thus 21 feet per second equals 21 multiplied by 2 divided by 3 = 14 m.p.h.

vi. The last three figures in each five-figure group give the true bearing from which the wind is blowing. This true bearing must be compared with the true bearing of the line of fire and converted to clock ray before the wind table is used.

vii. The groups always consist of the number of figures shown, 0's being prefixed if necessary. Thus 07004 would signify a 7 f.s. wind from a bearing of 4 degrees.

viii. Example :

Range to target	...	...	...	...	3850 yards
Height of gun position above mean sea level	...	...	...	...	500 metres
True bearing of line of fire	...	...	...	...	286 degrees

From telegram :—

(a) Barometer.	Reading at mean sea level	32.50 inches
	For altitude subtract	... 1.5 inches
		<u>31.00 inches</u>

This is 1" more than normal, therefore a correction is required.

From rangetable, 1" (plus) at 3850 requires Plus 32'

(b) Temperature.

Range 3850. Time of flight is 15 seconds.

From telegram, "1538". Air temperature for a 15 second time of flight is 38° F.

Normal is 60° F.

Difference is 22° F.

From rangetable, allowance for a 10° decrease at 3850 is 19'.

Therefore extra elevation is required to allow for the temperature.

19 × 2.2 or, say, plus 42'.

Allowance to be made for temperature Plus 42'

(c) Wind. (See Figure 13.)

From telegram, for a 15 second time of flight wind is 21 feet per second from a true bearing of 166°.

From diagram, angle between line of fire and wind is 286° - 166° = 120°.

To convert to clock ray, consider each hour to consist of 30°. Regard line of fire as 12 o'clock. Therefore this wind is coming from 8 o'clock.

Speed.

21 feet per second =  $21 \times 2 \div 3 = 14$  m.p.h.

A 10 m.p.h. wind at 3850 from 8 o'clock requires the following corrections :

For line : Left 41' Therefore a 14 m.p.h. wind requires  $\frac{41}{10} \times 14 = 57'$ .

For range : Minus 15' Therefore a 14 m.p.h. wind requires  $\frac{15}{10} \times 14 = 21'$ .

Corrections for fire order

Range 3850.	Tangent angle	...	...	12° 1'
Barometer	Plus	...	...	32'
Temperature	Plus	...	...	42'
				<u>13° 15'</u>
Wind	Subtract	...	...	21'
				<u>12° 54'</u>



Therefore ELEVATION  $12^{\circ} 55'$  (to nearest  $5'$ ).  
 LINE LEFT  $1^{\circ}$  ( $57'$  to nearest  $10'$ ).

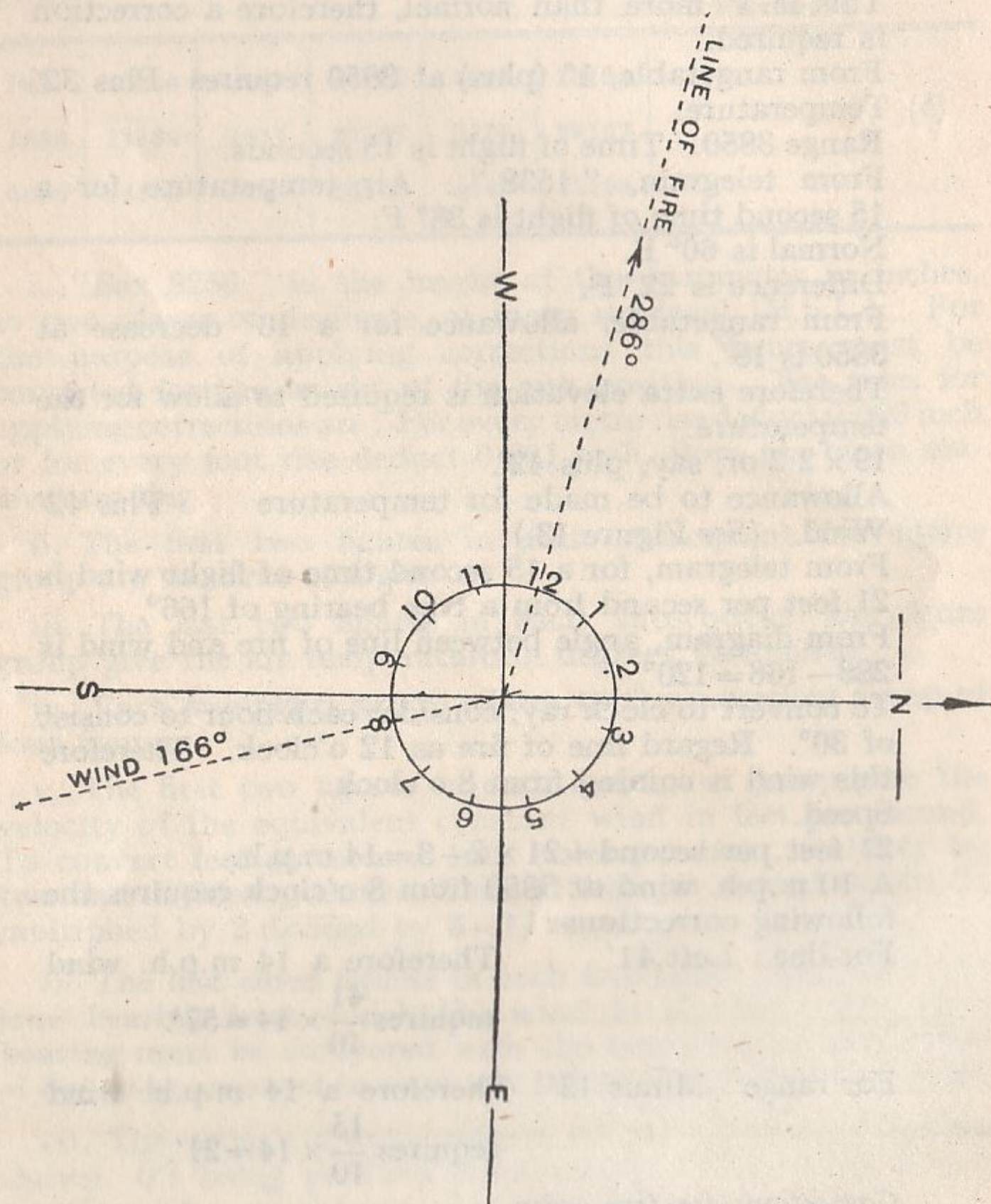


Figure 13

## LESSON 98.—THE COMBINED SIGHT RULE

### *Instructor's Notes*

Stores as for Lesson 97 ~~97~~ 100

*Explain :—*

1. Errors in elevation may be caused by :—
  - i. Inaccuracies in determining the range.
  - ii. Incorrect allowances for climatic variations.
2. The range may be determined by :—
  - i. Range-finding instrument—up to 2,800 yards.
  - ii. Measurement on a map of not less scale than 1/25,000.  
 For ranges over 2,300 yards this method is likely to be the most accurate provided that the map is in good condition and the gun position and target can be accurately located.
  - iii. Key-ranging.—That is by estimating from ranges taken by either of the above methods. This method is reasonably accurate up to 2,000 yards, but beyond that is of little practical value.

3. For fire effect to be obtained on a point target, it is necessary to ensure that the beaten zones cover all points at which that target may be, having regard to the error in determining the range.

For example, assuming the error in determining the range to be 10 per cent., and the range to have been given as 700 yards, the target may lie anywhere on the line of sight between 630 and 770 yards. At 700 yards, the length of the beaten zone along the line of sight is 195 yards, and it therefore extends from  $602\frac{1}{2}$  yards to  $797\frac{1}{2}$  yards range.

Thus, in this example, it more than covers all points where the target may lie.

In this example, it would be sufficient to fire with the gun or guns at one elevation (700) only, but at the longer ranges, when errors in determining the range increase and (up to 2,650) beaten zones decrease, it becomes necessary to fire on more than one elevation.

A "combined sight" table is therefore necessary to ensure that the fire controllers know how many elevations are needed at different ranges. This table is included in the range



tables, but for ranges up to 2,000 it is simple and should be learnt by heart :—

#### COMBINED SIGHT RULE

RANGE	No. of elevations required		
	Rangefinder	Map	Key Ranging
Up to 800 yards...	1	1	1
850 to 1,400 yards	1	1	3
1,450 to 2,000 yards	3	3	5
2,050 to 2,300 yards	5	5	—
2,350 to 2,800 yards	7	5	—
2,850 to 4,500 yards	—	5	—

4. Fire will be opened with all guns at the range obtained, plus or minus any allowance for head or rear winds. This procedure ensures that the best use is made of any observation of strike of the bullets.

If three elevations are required by the combined sight rule, they will be the opening elevation, and the elevations 50 yards less and 50 yards more.

If five elevations are required, they will include also the ranges 100 yards above and 100 yards below the opening range.

5. If good observation of fire is obtained, the combined sight rule will not be applied.

#### SECTION 24.—DIRECT FIRE

1. The direct fire unit is the section, because :—
  - i. Two guns are required to give the necessary volume at the most usual machine gun ranges.
  - ii. At longer ranges, two guns are required to ensure hitting the target without undue delay.
  - iii. In event of stoppage of one gun, sustained fire can be maintained by the other.
  - iv. It can easily be concealed and is not too vulnerable.
2. The requirements of fire control necessitate the two guns being under the command of a fire controller who is supplied with a range-taker to enable him to determine the range and observe the fire.
3. In order to avoid casualties the two guns of a section in action should be as far apart as possible, provided that the section commander is able to control both guns by voice.
4. With reference to paragraph 1 above, at distances beyond 2,000 yards the volume of fire produced by a section cannot always be relied on to give results proportionate to the expenditure of ammunition, and the fire of two or more sections may have to be directed on to the same target from their respective positions.

#### LESSON 29.—FIRE ORDERS—DIRECT

##### Instructor's Notes

##### Stores :—

Two guns and tripods, director, range tables, slide rules, landscape target, blackboard.

After an initial lecture with blackboard and landscape target, this lesson should, whenever possible, be carried out out-of-doors.

1. Explain that the following is the procedure for engaging a target by a direct fire unit.
  - i. The fire controller, by means of a fire order, gives an elevation and indicates a point of aim on the target for each gun.



- ii. Each firer sets his tangent sight at the elevation ordered, and by tapping the gun, and by use of the elevating handwheel, directs the line of sight on to the point indicated for the gun. Thus the gun is laid initially for both elevation and direction.

2. Fire orders are given in a sequence, laid down in paragraph 3, below, and must not be departed from.

Rigid adherence to the sequence will ensure that errors and omissions are detected immediately, and, further, that the personnel, knowing what to expect, will act more quickly.

The orders must be given loudly and clearly, the fire controller facing towards the guns.

He must make up his mind what is the correct order to give before embarking on it. Long and unnecessary pauses, during which he is coming to a decision as to the next part of the order, can result only in inaccuracies and slovenly drill.

The recipients must have time to act on one portion of the order before another is given.

Reference points and degrees should be used only when they are necessary in order to indicate the target clearly. The best fire order is that which gets bullets on to the target in the shortest possible time.

3. The sequence of a direct fire order is:—

- i. Range or ranges (including wind allowance if necessary).
- ii. Indication of the target.
- iii. Method of fire.
- iv. Side wind allowance.
- v. Rate of fire (if required).
- vi. Order to fire.

When giving out the order, pauses should be made as under, until it is seen that the gun numbers are ready for the next part of the order.

After the range ... To allow time to set the sights.

At various stages during the indication. Time must be given for points to be recognized. When degree methods of indication are used, a pause must be made to enable the angles to be measured.

After method of fire ... To enable the guns to be laid.

After wind, if any .. To allow of picking up a gun aiming mark.

#### 4. Range or ranges

i. Ranges, when ordered to the guns, will be given to the nearest fifty yards, and according to the following examples:—

700—Seven hundred.

1,000—~~Ten~~ hundred. *one thousand*

1,400—Fourteen hundred. *one four hundred*

1,450—Fourteen fifty. *one four fifty*

2,000—Twenty hundred. *two thousand*

2,300—Twenty-three hundred. *two three hundred*

2,350—Twenty-three fifty.

ii. For the first target the section commander will usually obtain the range from the range-taker, but where the situation demands it, he should not hesitate to estimate the range. For subsequent targets, to save time, ranges are taken, or estimated, from the range card.

iii. If one range is ordered to the two guns the range will be preceded by the word "all", e.g. "all—twelve hundred."

If two elevations are necessary, they will be given in the form:—

"Number 1—~~Sixteen~~ fifty."

"Number 2—~~Seventeen~~ fifty."

iv. If the wind is sufficiently high to warrant a correction for elevation, the allowance required will be calculated in yards (Lesson 37). The range will be corrected before being given out.

#### 5. Indication

The section commander will indicate the target as laid down in Lessons 62 and 63. It should be noted that when switching from one target to another the last target is often the best aid in indication.

#### 6. Method of fire

i. (a) Order "right and left . . . taps."

Both guns are laid on the centre of the target.

Number 1 gun taps to the left first and Number 2 to the right.

(b) Order "traversing."

Number 1 gun is laid on the right end and Number 2 on the left end of the target.



NOTE.—In engaging an oblique target, this order to traverse will be preceded by “**Number 1 right half—Number 2 left half.**”

On completion of the “method of fire” order the section commander will order “**lay.**”

#### 7. Side wind

The section commander will either estimate the side wind required or calculate it to the nearest tap (Lesson 97). It will be ordered to the guns in the following form:—

“**Wind—right (or left) . . . taps.**”

Numbers 1 tap their guns across by the number of taps ordered, pick up a gun aiming mark, and inform Numbers 2 when ready. Numbers 2 look through the sights and pick up gun aiming marks.

If the allowance required is  $1^\circ$  or more, it should be ordered in degrees. Numbers 1 by means of a hand angle pick up a gun aiming mark.

If no correction is necessary, this heading is omitted from the order.

#### 8. Rates of fire

If no order is given, normal is implied.

If it is desired to fire “Rapid,” the order will be given after the allowance for wind, if any.

#### 9. The order to fire

This will normally be given by the fire controller ordering “**fire.**” If more convenient he may signal “**fire.**” (See Section 13, Signals.)

Attention is called to Lesson 96—Length of bursts.

10. The following orders may be given during a shoot:—

##### i. “**Stop.**”

This order is normally given by signal, the arm being waved horizontally to and fro.

##### ii. **Ranging corrections.**

###### (a) Direction

The section commander converts the necessary deflection into taps, which he orders to one or both guns as required. Numbers 1 pick up a gun aiming mark in the new line. Should a No. 1 see good strike he should make any necessary correction for direction without waiting for orders.

Examples:—

“**All— . . . Right two taps.**”

“**Number 1— . . . Left three taps.**”

#### (b) Elevation

The section commander decides on the correction, and either gives out a new range or orders “**up**” or “**down**” by the amount required.

Examples:—

“**All—Fourteen hundred.**”

“**All—Up two hundred.**”

“**Number 2—Up one hundred.**”

“**All—Down fifty.**”

In applying the combined sight rule to cases where the two guns of a section are to have different elevations, the lower elevations will be given to Number 1 gun.

##### iii. “**Go on.**”

This order may be given verbally or by making the signal to fire.

#### 11. Practise squad in open country.

## LESSON 100.—METHODS OF FIRE

### Instructor's Notes

Stores:—

*Blackboard, landscape target.*

*The subject matter will be given in the form of a lecture.*

#### 1. Explain

**Types of targets** which machine guns will be required to engage are classified as:—

- i. Point targets. (Lesson 101.) 104
- ii. Targets with width having the same range to each end. (Lesson 102.) 105
- iii. Oblique targets having a different range to each end. (Lesson 103.) 106
- iv. Targets with depth. (Lesson 104.) 107
- v. Area targets. (Lesson 104.) 107
- vi. Moving targets. (Lesson 105.) 108

2. The firer is taught the required strength of tap to displace the line of sight by 15', this being the amount which it is calculated will cause successive beaten zones to overlap slightly. This tap is called the “regulation 15' tap.”



### 3. Errors in direction may be caused by:—

- i. Wrong estimation of wind.
- ii. Slight inaccuracies of aim, wear in the mounting, etc.

As these errors may act either way, it will be necessary to engage an additional width on either side of the target. Lateral errors will not normally be great, but the beaten zone is narrow and so does not give much help in overcoming them.

The error increases in proportion to the range, and therefore a greater width will require to be engaged at long ranges than at short.

## LESSON 101—POINT TARGETS

### Instructor's Notes

#### Stores:—

Blackboard, landscape target, field glasses, spotlight apparatus if available.

1. Explain that errors in direction are overcome by the application of the following rule:—

*Up to 800 yards inclusive.*—The error should be covered by the width of the beaten zone.

*Between 850 and 1,400 yards.*—One tap right and left.

*Above 1,400 yards.*—Two taps right and left.

2. Illustrate a fire unit engaging a point target at a range of 1,600 yards obtained by range-finder, requiring two taps right and left. (Figure 14.)

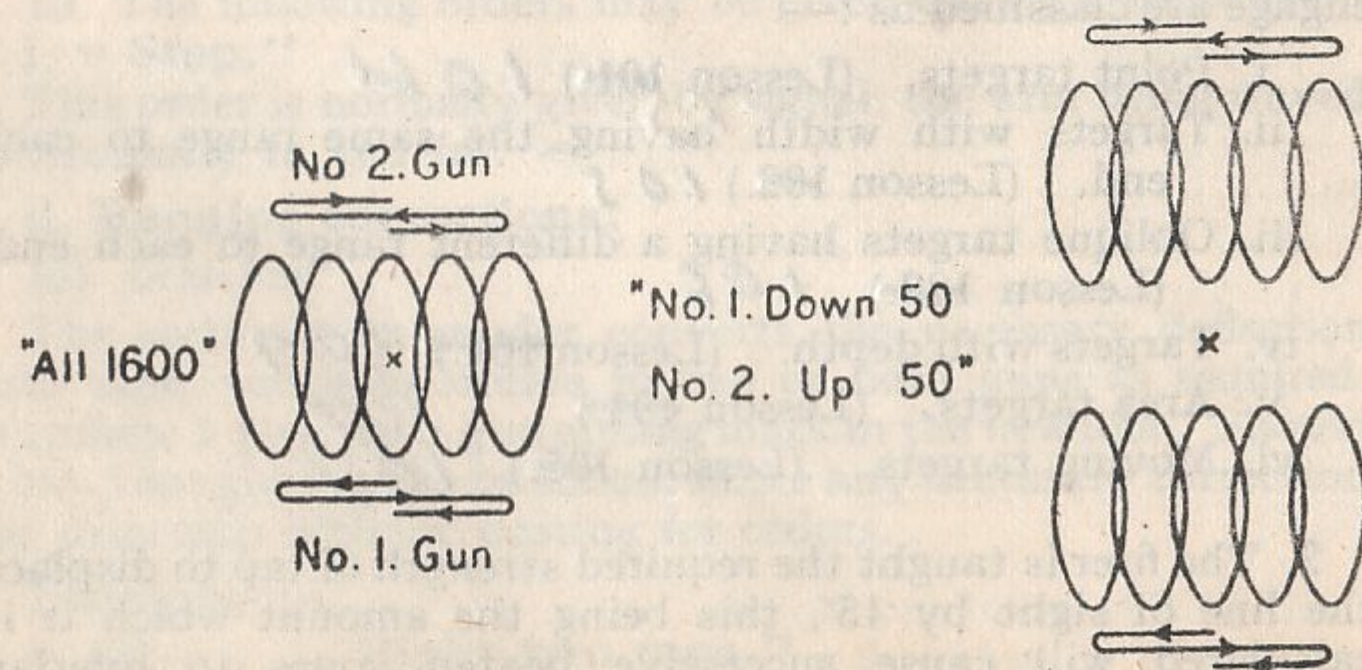


Figure 14.—Tapping right and left.

3. Explain and show examples that if the point of aim is indefinite, an extra tap right and left must be given.

4. Explain that in engaging *point targets*, the fire controller will indicate the centre of the target as the point of aim for both guns. Targets with a little width will also be engaged in this way, the number of taps required according to rule above being increased to cover the extra width. To calculate the number of taps required for width: measure the angular width of the target—divide by 2, and take to the nearest 15'

e.g. Target 20' wide,

Divide by 2 = 10'

Take to the nearest 15' = one tap right and left.

As a guide, if the number of taps right and left to be given exceeds three, the target will be treated as a target with width.

5. With the aid of the "Apparatus, Weapon Training, Spotlight, Mark II," practise the engagement of point targets.

6. Examples of fire orders to engage point targets.

The following reference points have been selected on the landscape as shown in Plate 26.

i. Haystacks (R.P.1)—left bottom corner known as **stack**.

ii. Two poplars (R.P.2)—left poplar known as **poplar**.

Target "A." Point target 750 yards.

All 750.

Right of arc—pond—near side—large tree.

Lay.

Rapid fire.

Target "B." Point target 1,600 yards (range-finder).

All 1,600.

Poplar—right 3 o'clock 3 degrees—bush.

Right and left 2 taps.

Lay.

Wind—right—1 tap.

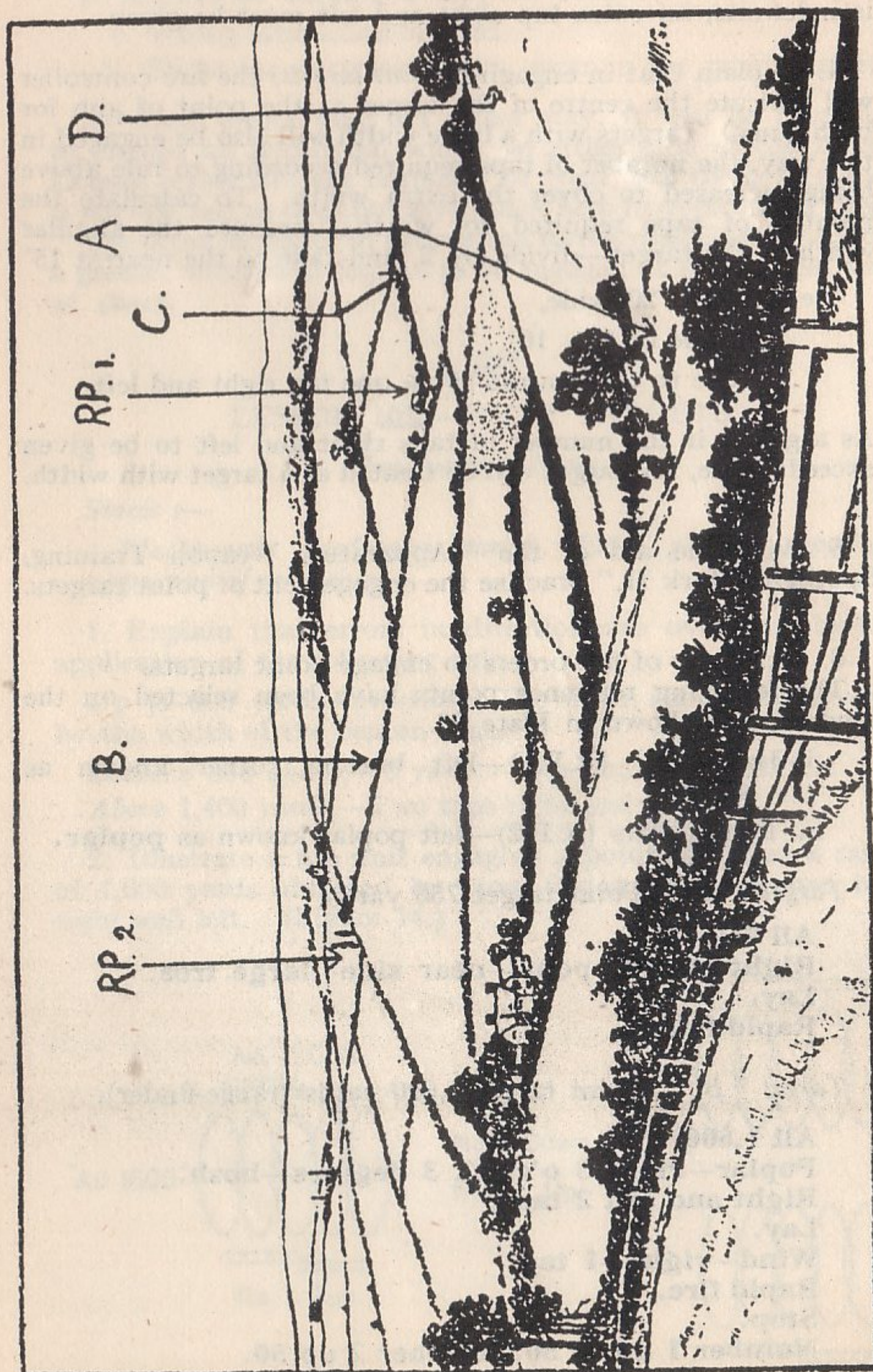
Rapid fire.

Stop.

Number 1 down 50, Number 2 up 50.

Go on.





Target "C." Point target 1,600 yards estimated.

All 1,600.

Stack—right 2 o'clock 2 degrees—corner of field.

Right and left 2 taps.

Lay.

Fire.

Stop.

Number 1 down 50.

Number 2 up 50.

Go on.

Stop.

Number 1 down 50.

Number 2 up 50.

Go on.

Target "D." Point target 1,150 yards (range-finder)  
45' wide.

All 1,150.

Right of arc—4 large trees.

Right and left 3 taps.

Lay.

Wind—left 1 tap.

Rapid fire.

# LESSON 102.—TARGETS WITH WIDTH HAVING THE SAME RANGE TO EACH END

## Instructor's Notes

Stores as for Lesson 101. **LOH**

1. Explain that errors in direction are overcome by the firer always traversing outside the flanks by one tap.

2. Explain that in engaging targets with width Number 1 gun will be laid on the right end, Number 2 on the left end. Each gun will engage the whole target. The engagement of a target in this way is known as *traversing*.



3. *Illustrate.*

A fire unit engaging a target about 100 yards wide. (Figure 15.)

- i. x . . . x are the original points of aim.
- ii. The dotted beaten zones on the flanks of the target represent one tap outside. (See paragraph 1, above.)

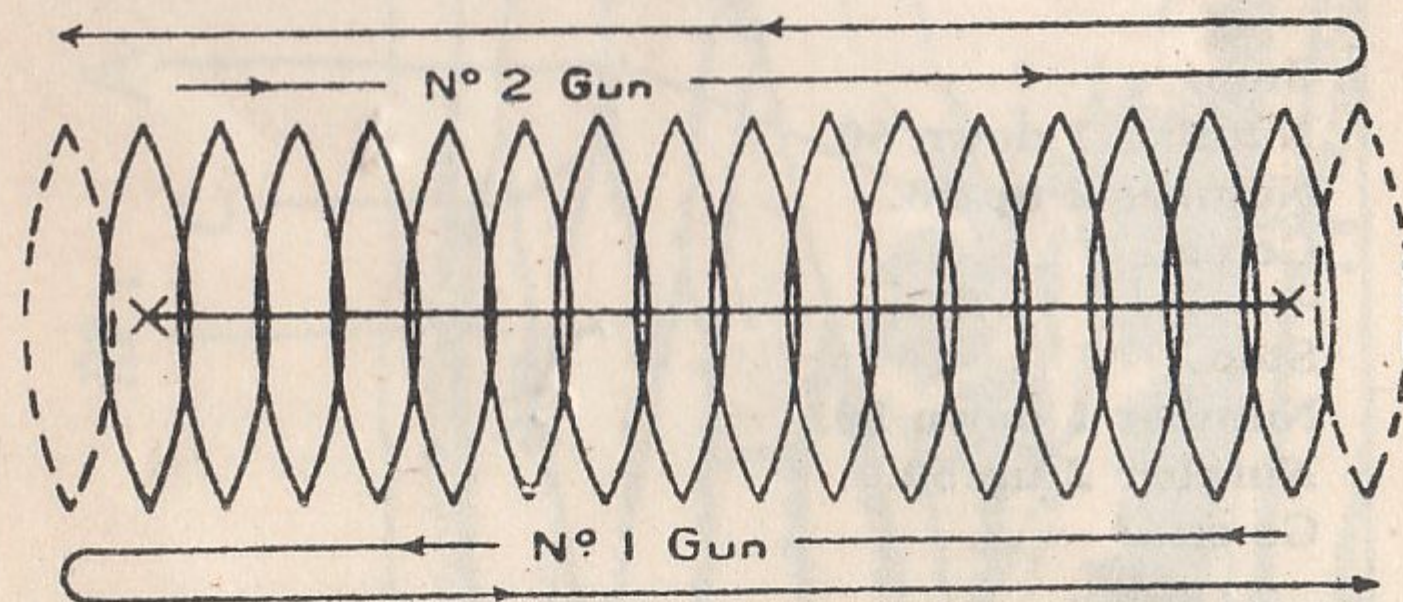


Figure 15.—Traversing

4. With the aid of the spotlight apparatus practise the engagement of targets with width.

5. Examples of fire orders to engage targets with width.

The following reference points have been selected on the landscape as shown in Plate 27.

- i. Haystacks (R.P.1) left bottom corner known as **Stack**.
- ii. Two poplars (R.P.2) left poplar known as **Poplar**.

Reference to Plate 27

Target "E." Target with width 800 yards (estimated).

All 800.

Poplar—6 o'clock right end of house—left limit.

Right 3 o'clock 2 degrees—bush—right limit.

Traversing.

Lay.

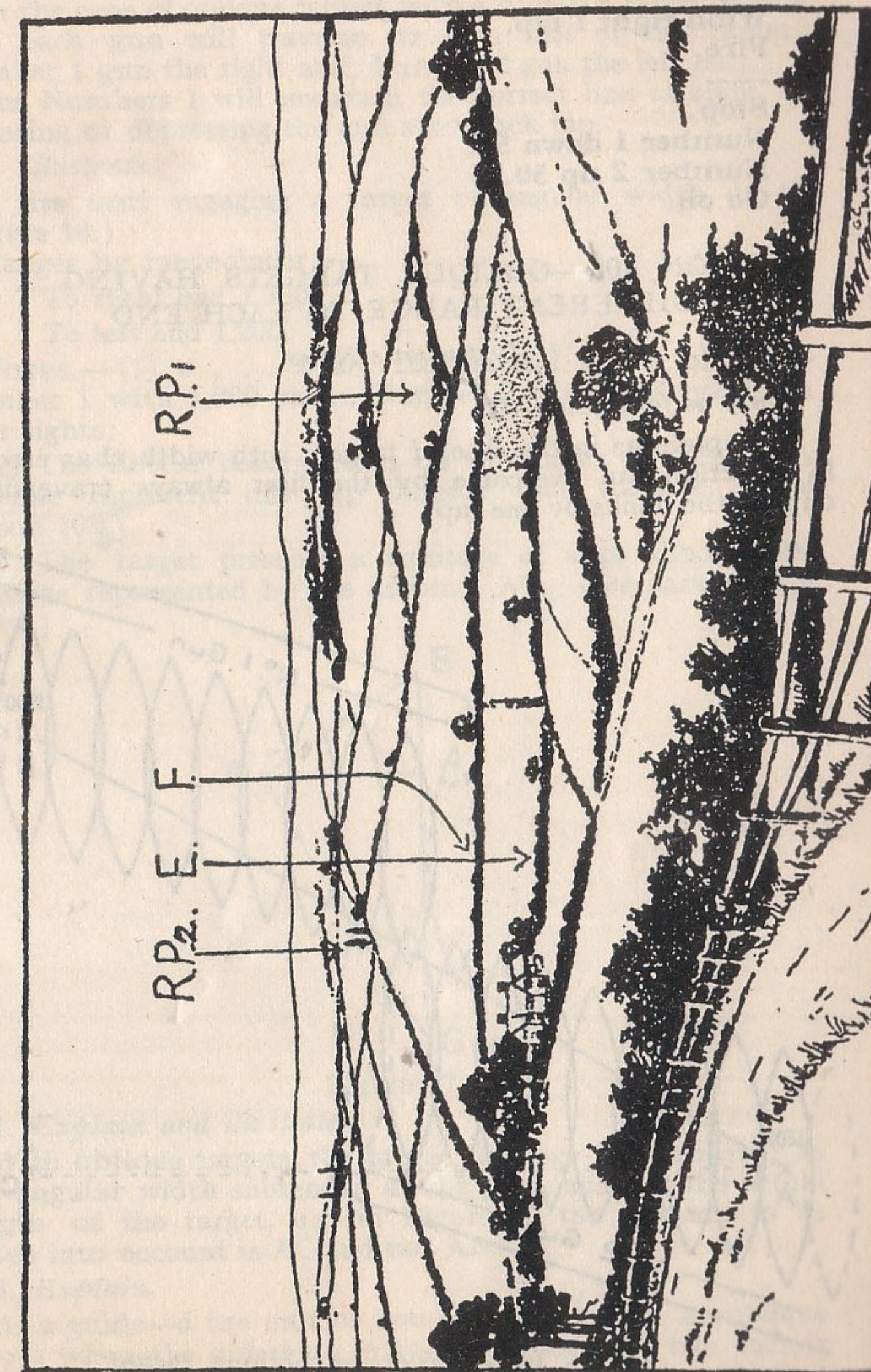
Rapid fire.

Target "F." Target with width, range 1,300 yards (estimated).

All 1,300.

Poplar—right 4 o'clock 4 degrees—bush—from bush to left 9 o'clock—where hedgerow disappears behind large trees.

PLATE 27





Traversing.

Lay.

Wind right 1 tap.

Fire.

Stop.

Number 1 down 50.

Number 2 up 50.

Go on.

# LESSON 102—OBLIQUE TARGETS HAVING A DIFFERENT RANGE TO EACH END

*Instructor's Notes*

Stores as for Lesson 102.

1. Explain as in the case of targets with width that errors in direction are overcome by the firer always traversing outside the flanks by one tap.

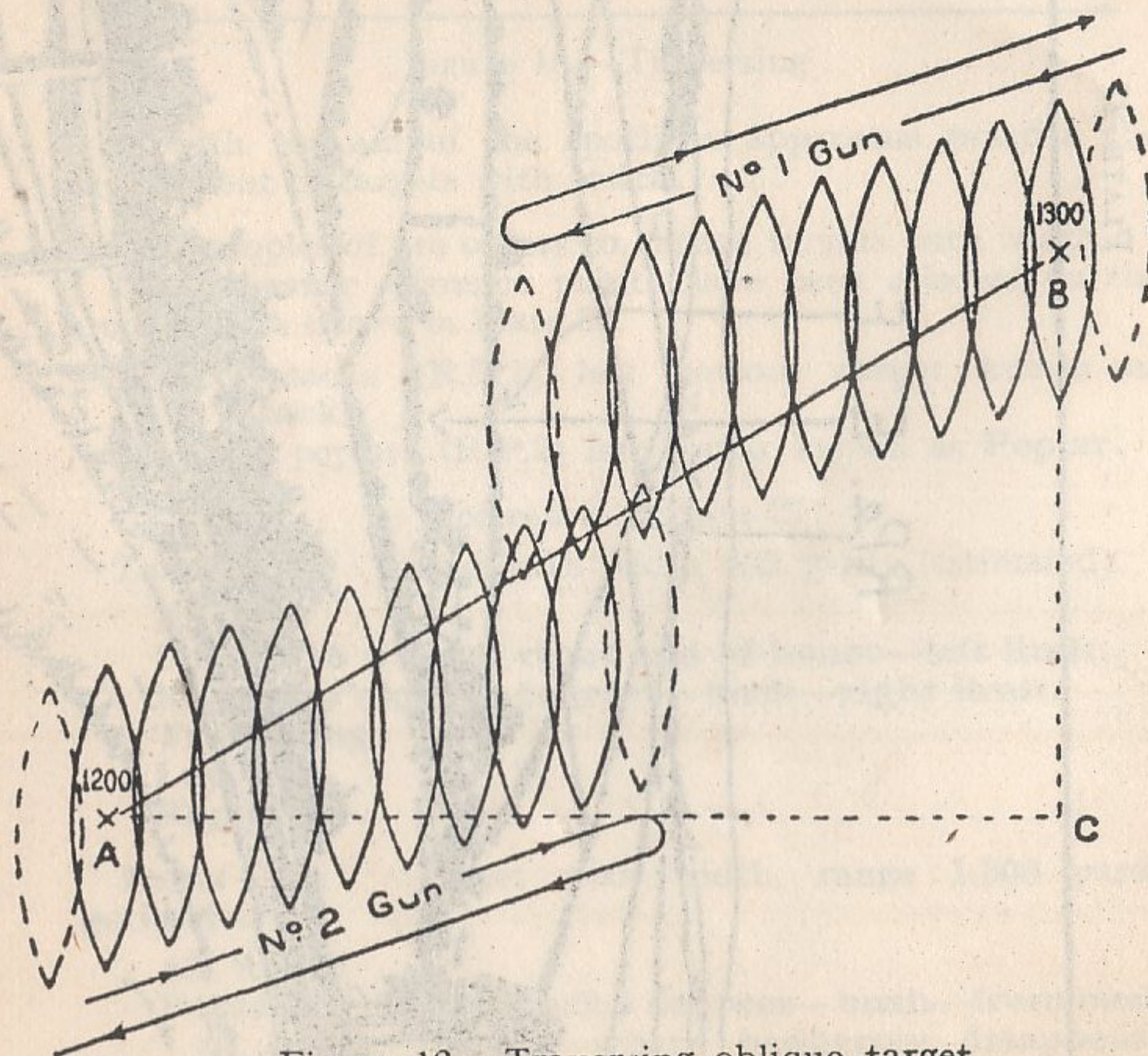


Figure 16.—Traversing oblique target

2. Explain.

In the case of oblique targets with a different range to each end, each gun will traverse its own half of the target: Number 1 gun the right half, Number 2 gun the left half.

The Numbers 1 will maintain the correct line of sight by elevating or depressing the gun after each tap.

3. Illustrate.

A fire unit engaging a target of angular width of  $4^\circ$ . (Figure 16.)

Ranges by range-finder:—

To right end 1,300.

To left end 1,200.

NOTES.—(1) x . . . x are the original points of aim—Number 1 with 1,300 yards, Number 2 with 1,200 yards on their sights.

(2) The dotted beaten zones on the flanks of each gun's traverse represent one tap outside that traverse. (See Lesson 102.)

(3) The target presents a frontage of approximately 90 yards as represented by the distance AC. (See paragraph 4 below.)

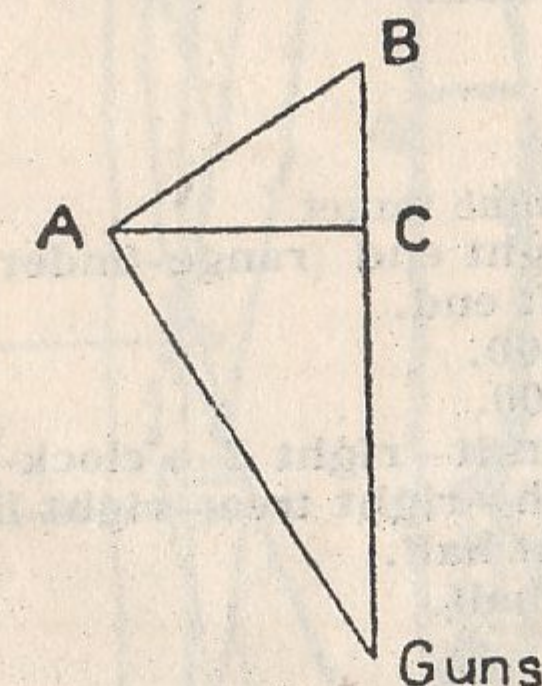


Figure 17.

4. Explain and illustrate.

With oblique targets, the target frontage is considered as the angular width subtended at the guns, and not the actual length of the target, e.g. in Figure 17 the distance to be taken into account is AC and not AB.

5. Explain.

As a guide—a fire unit of two guns can engage an oblique target when the difference in range between the two ends is not more than 100 yards. If the difference exceeds that



distance, only a portion of the target should be engaged at one time.

6. With the aid of the spotlight apparatus, practise the engagement of oblique targets.

7. Examples of fire orders to engage oblique targets.

The following reference points have been selected on the landscape as shown in Plate 28.

i. Haystacks (R.P.1) left bottom corner known as **Stack**.

ii. Two poplars (R.P.2) left poplar known as **Poplar**.

Reference to Plate 28.

Target "G." Oblique target.

1,250 yards right end (range-finder).

1,150 yards left end.

Number 1, 1,250.

Number 2, 1,150.

Poplar—left 8 o'clock—junction of hedgerow—  
right limit—left 8 o'clock—end of hedgerow—  
left limit.

Number 1 right half.

Number 2 left half.

Traversing.

Lay.

Fire.

Target "H." Oblique target.

1,600 yards right end (range-finder).

1,500 yards left end.

Number 1, 1,600.

Number 2, 1,500.

Poplar—left limit—right 2 o'clock—trees at right  
end of church—right tree—right limit.

Number 1 right half.

Number 2 left half.

Traversing.

Lay.

Wind left 2 taps.

Fire.

Stop.

All down 50.

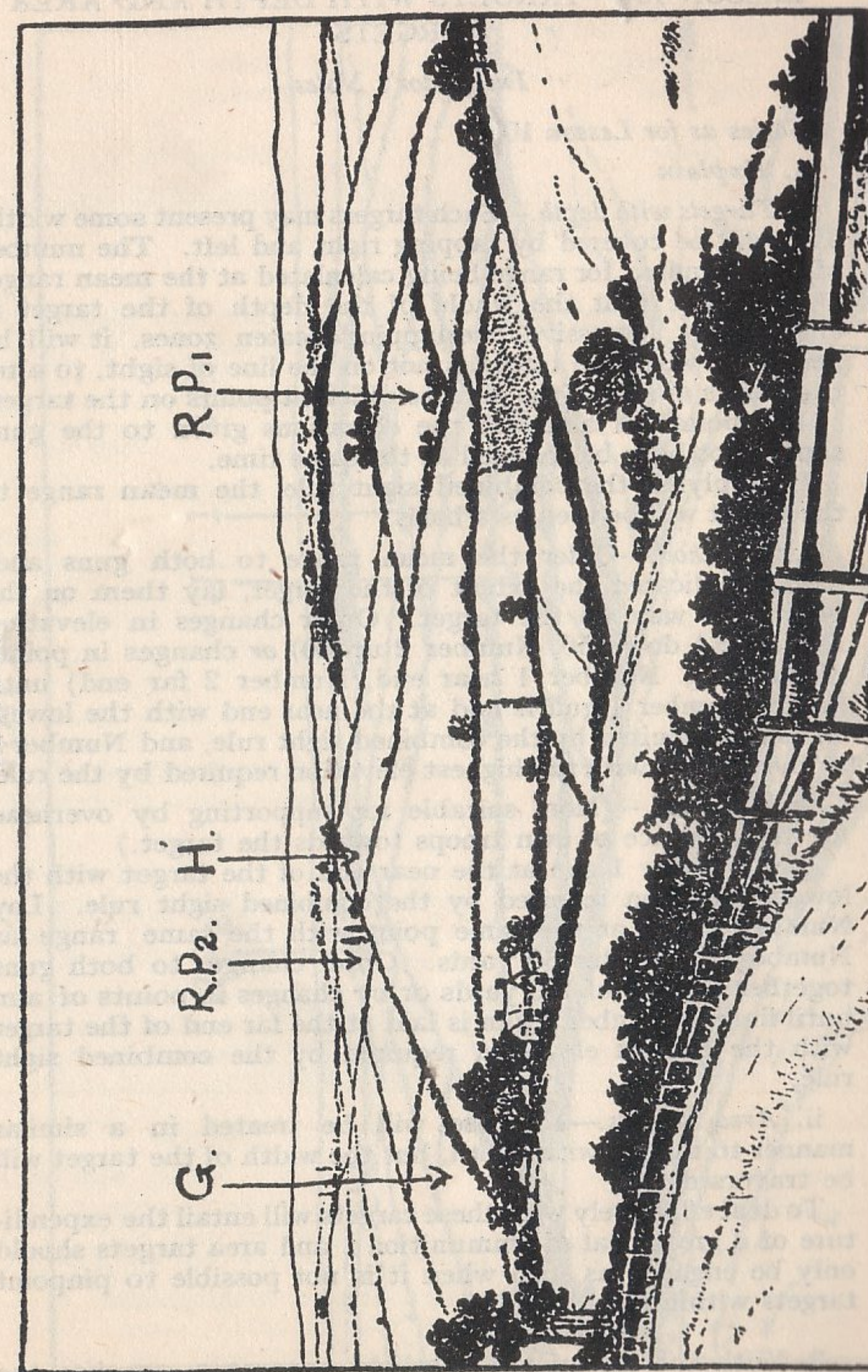
Go on.

Stop.

All up 100.

Go on.

PLATE 28





# LESSON 104—TARGETS WITH DEPTH AND AREA TARGETS

## Instructor's Notes

Stores as for Lesson 103

### 1. Explain

i. *Targets with depth.*—Such targets may present some width. This will be covered by tapping right and left. The number of taps required for range being calculated at the mean range.

To ensure that the whole of the depth of the target is engaged by successive overlapping beaten zones, it will be necessary when the target is not on the line of sight, to alter the points of aim of the guns to different points on the target.

The points of aim and the elevations given to the guns should not both be changed at the same time.

In applying the combined sight rule, the mean range to the target will be used as a basis.

*1st Method.*—Order the mean range to both guns and, having indicated the extent of the target, lay them on the point half way up the target. Order changes in elevation (Number 1 down 50, Number 2 up 50) or changes in points of aim (e.g. Number 1 near end, Number 2 far end) until finally Number 1 gun is laid at the near end with the lowest elevation required by the combined sight rule, and Number 2 at the far end with the highest elevation required by the rule.

*2nd Method.*—(More suitable for supporting by overhead fire the advance of own troops towards the target.)

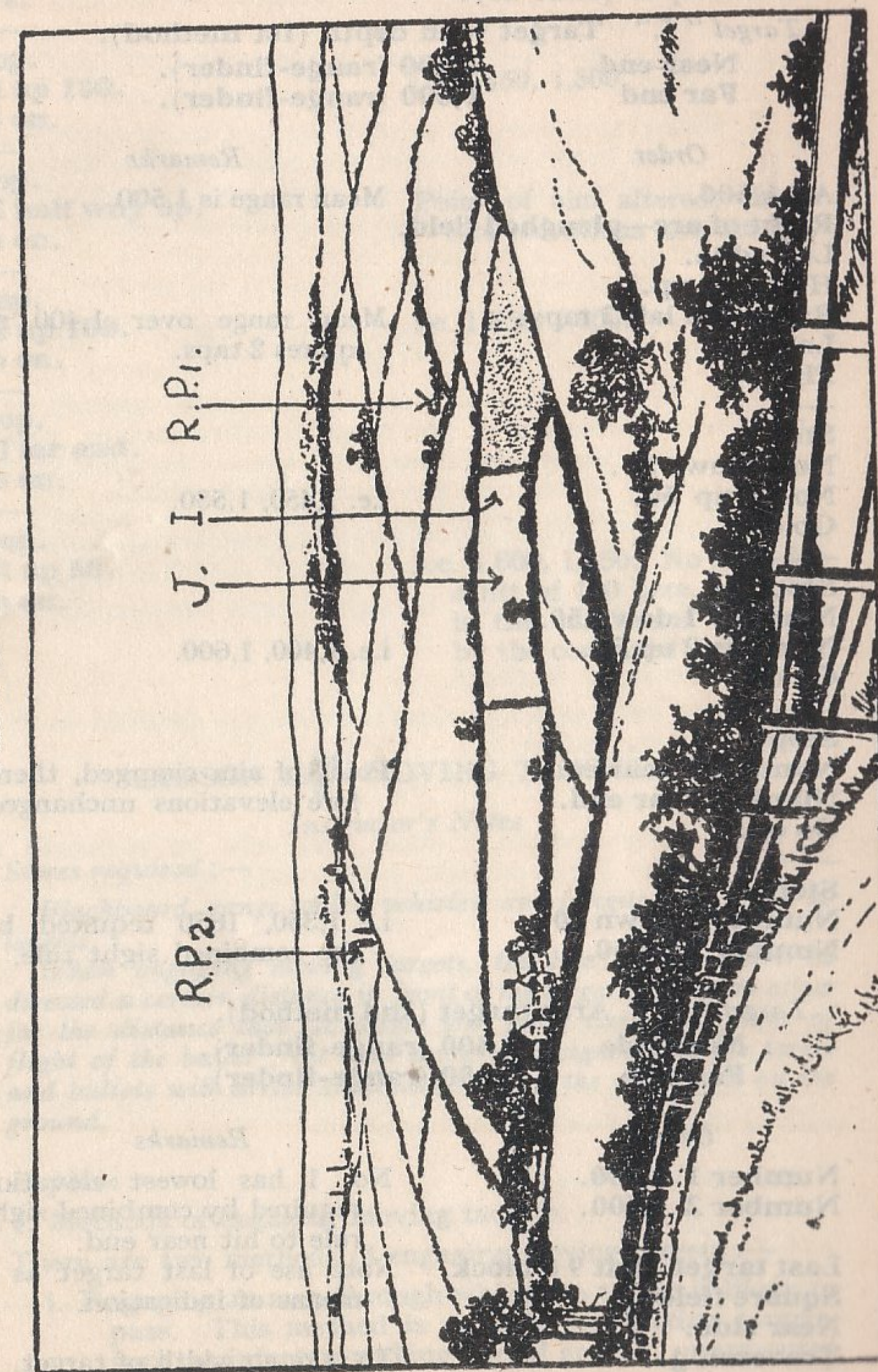
Lay Number 1 gun at the near end of the target with the lowest elevation required by the combined sight rule. Lay Number 2 gun at the same point with the same range as Number 1 gun plus 50 yards. Order changes to both guns together by lifts of 100 yards or by changes in points of aim until finally Number 2 gun is laid at the far end of the target with the highest elevation required by the combined sight rule.

ii. *Area targets.*—1. These will be treated in a similar manner to targets with depth, but the width of the target will be traversed.

To deal effectively with these targets will entail the expenditure of a great deal of ammunition; and area targets should only be engaged as such when it is not possible to pinpoint targets within the area.

2. With the aid of the spotlight apparatus, practise the engagement of targets with depth and area targets.

PLATE 29





## 3. Examples (Plate 29) :—

## Target "I." Target with depth (1st method).

Near end 1,400 (range-finder).  
Far end 1,600 (range-finder).

Order	Remarks
All 1,500. Right of arc—ploughed field. Left edge. Half way up. Right and left 2 taps. Lay. Fire.	Mean range is 1,500.
Stop. No. 1 down 50. No. 2 up 50. Go on.	i.e. 1,450, 1,550.
Stop. Number 1 down 50. Number 2 up 50. Go on.	i.e. 1,400, 1,600.
Stop. Number 1 near end. Number 2 far end. Go on.	Point of aim changed, therefore elevations unchanged.
Stop. Number 1 down 50. Number 2 up 50.	i.e. 1,350, 1,650 required by the combined sight rule.

## Target "J." Area target (2nd method).

Near side 1,400 (range-finder).  
Far side 1,600 (range-finder).

Order	Remarks
Number 1 1,350. Number 2 1,400.	No. 1 has lowest elevation required by combined sight rule to hit near end.
Last target—left 9 o'clock. Square field. Near side. Traversing. Lay.	Note use of last target as a means of indication. To take up width of target.

## Fire.

Stop.  
All up 100. i.e. 1,450, 1,500.  
Go on.

Stop.  
All half way up. Point of aim altered, therefore elevations not altered.  
Go on.

Stop.  
All up 100. i.e. 1,550, 1,600.  
Go on.

Stop.  
All far end.  
Go on.

Stop.  
All up 50. i.e. 1,600, 1,650. No need for a lift of 100 here, as 1,650 is the maximum required by the combined sight rule.  
Go on.

## LESSON 105.—MOVING TARGETS

## Instructor's Notes

## Stores required :—

Blackboard, range tables, vehicles, and fatigue men to act as targets.

When engaging moving targets, the line of fire must be directed a certain distance in front of the target in order to allow for the distance that the target will move during the time of flight of the bullet ; the lead being so designed that the target and bullets will arrive simultaneously at the same spot on the ground.

## Explain

## 1. Methods of engaging moving targets.

There are two methods of engaging moving targets :—

- Engaging an area through which the target is likely to pass. This method is suitable for fleeting targets, such as infantry making use of ground, unarmoured vehicles, and cavalry.



It is carried out by selecting areas through which the target is likely to pass, and giving an anticipatory fire order based on the estimation of speed and direction of the target.

- ii. Swinging traverse : suitable against moving targets at close range, when other methods would be too slow ; or when the target is particularly suited for this method of engagement, e.g. a line of infantry.

## 2. Fire control.

i. Fire orders must be short and simple, otherwise the opportunity of engaging the target may be lost.

ii. The fire unit commander will maintain control until, owing to the closeness of the range or other factors, greater fire effect may be expected from gun control. He must change to gun control before unit fire control breaks down.

iii. When engaging a moving target, whether by section or gun control, attention must be directed continually to:—

- (a) The changing line of sight, both horizontally and vertically.
- (b) Alterations in range.
- (c) The amount which the fire has to be directed in front of the target.

This depends upon the speed and direction of the target.

The maximum effect will only be obtained by quick judgment and a thorough knowledge of the machine gun beaten zone.

3. The approximate angle in minutes through which the target will travel during the time of flight of the bullet can be determined by multiplying the target speed in miles per hour by the factor 5, at all ranges.

For targets moving obliquely across the line of fire a proportion of this allowance should be given.

*Examples.* (Plate 29.)

1. *Target.* Two motor cycle orderlies moving from right to left at about 10 m.p.h.

*Method of engagement.* By engaging an area through which the target is likely to pass.

The allowance for the time of flight of the bullet = 10 m.p.h.  $\times 5 = 50$  minutes.

Anticipatory fire order :

**All 1,400.**

**Poplar—6 o'clock—house—right 3 o'clock junction of hedgerows.**

**Lay.**

**Wind left 1 tap.**

**Fire.**

NOTE.—The fire controller picks up a point 50 minutes to the right of the junction of hedgerows. When the target reaches this point, he gives the order "Fire."

2. *Target.* Enemy advancing across field on far side of road in foreground.

Range 400 yards.

Fire order :

**All : battle sights.**

**Centre of arc—enemy advancing across field.**

**Swinging traverse.**

**Fire.**



## SECTION 25.—INDIRECT FIRE

1. The indirect fire unit is normally the platoon because :—
  - i. The gun position is not in view of the enemy, and therefore concealment and control of four guns is possible.
  - ii. Indirect fire is usually employed at the longer ranges, when the fire of four guns is desirable to produce the requisite volume.

The platoon, however, carries the necessary equipment for sections to employ indirect fire independently. In an indirect fire position the normal gun interval is 15 yards.

2. The opening of fire rapidly and effectively by indirect means depends on accuracy in the use of the various instruments and minute precision in drill. Such accuracy and precision can be attained only by a high standard of training and frequent practice.

3. The principles and methods laid down in the following sections apply to any number of machine guns that may be grouped together as a fire unit under one fire controller.

The platoon is referred to throughout for reasons of brevity and simplicity.

## LESSON 106.—FIRE ORDERS—INDIRECT

*Stores :—*

*Blackboard, range tables.*

*The lesson should be carried out in the form of a lecture.*

### 1. Explain.

The following is the procedure for engaging a target by indirect fire :—

The methods of laying guns by indirect means consist of giving direction to the guns by laying off a point seen from the gun position. Elevation is calculated from the horizontal plane, and is placed on the gun by means of the dial sight. Direction is maintained by means of an aiming mark, usually an aiming post. Such a mark also assists in maintaining elevation. The use of the clinometer level is the method of checking the elevation.

2. The form of orders given and the action to be taken will be found in Section 18.

The sequence of an indirect fire order will be :—

- i. Zero lines.
- ii. Angles of switch.
- iii. Elevation or elevations (including wind allowance if necessary).
- iv. Load.
- v. Distribution (if any).
- vi. Tapping right and left.
- vii. Side wind allowance.
- viii. Rate of fire (if required).
- ix. Order to fire (as for direct fire).

### 3. Notes on indirect fire orders.

#### i. Zero lines. (Lesson 107.)

Before giving out angles to the respective guns, the order "**zero lines**" will be given. The angles are given to the nearest ten minutes.

#### ii. Elevation or elevations. (Lesson 113.)

If a correction for atmospheric influences is necessary, it will be added to, or subtracted from, the angle of sight or Q.A. before the latter is given out. (Lesson 97.)

Angles of sight and quadrant angles are converted to the nearest 5' before being passed to the guns.

The elevation is given to the guns as under :—

**"All (or Number . . .) . . . hundred.**

**Plus (or minus) . . . degrees . . . minutes."**

**or "Elevation (or depression) All (or Number . . .) . . . degrees . . . minutes."**

#### iii. Distribution. (Lesson 112.)

The order for distribution will always start with the pivot gun, for which the order "**nil**" is given. The angles of deflection for the other guns are given to the nearest 10'.

#### iv. Tapping right and left.

The amount of traverse will be given in "taps," as for direct fire.

Numbers 1 and 2 guns tap to the left first, Numbers 3 and 4 to the right first.

#### v. Side wind allowance. (Lesson 97.)

The allowance is calculated for the range from the gun position, and ordered to the nearest 10'.



4. *Orders during a shoot.*i. *Lifts.*

If in yards will be given to the guns in the form :—

**“All—up . . . (hundred or fifty).”**

If in minutes will be determined from the range table, and given in the form—

**“All—up . . . minutes.”**

This order may be given verbally or by signal as detailed in sub-paragraph ii (b), below.

ii. *Ranging corrections.*(a) *Direction.*

The amount of switch required is measured by the director, glasses, or by slide rule according to the time available.

The correction may be given verbally, or the following semaphore signals may be employed :—

**T . . . right 30’.**

**L . . . left 30’.**

To double or increase further the corrections, the code letter will be repeated as necessary.

(b) *Elevation.*

The fire controller estimates the correction required in hundreds of yards, and orders the result in the form :—

**“All—up (or down) . . . (hundred or fifty).”**

This order may be sent by semaphore signal as follows :—

**U . . . up 50 yards or 10’.**

**N . . . down 50 yards or 10’.**

To double or increase further the correction, the code letter will be repeated as necessary.

If during the shoot it is seen that any gun or guns are firing over or short as compared with the remainder, the order **“check elevations”** will be given.

iii. *The engagement of a fresh target.*(a) *Direction.*

The fire controller measures the angle of switch for the pivot gun as in sub-paragraph ii (a), above. In order that the lines of fire may be parallel, before switching, he will order the guns to relay on their zero lines with dial sights at zero, by giving the order :—

**“All—on zero lines.”**

The angle of switch is then given out.

If the switch is very large, it may be convenient to correct the zero line on to the new target ; in this case, the order for

the angle of switch will be preceded by the words **“zero lines.”**

(b) *Elevation.*

The angle of sight to the new target is taken with a director.

The elevation for the new target is calculated and ordered to the guns as in 3 (ii), above.

(c) The remainder of the fire order is normal, depending on the type of target.

(d) During pauses in the firing, and at any other time when it is possible, it is the duty of the fire controller to measure switches, and, with the assistance of his range-taker, to calculate the elevation for all probable targets in his arc. This calculation may reduce the time taken to open fire on new targets.

## LESSON 107.—GENERAL PRINCIPLES

*Instructor's note.**Stores :—**Blackboard.*1. *Explain*i. *Zero lines.*

Lines which are parallel, when swung through the same angle, remain parallel.

Therefore, to provide a basis from which fire can be switched in any direction, all guns are, by various means, initially placed on parallel zero lines. (See Figure 18.)

The choice of the actual direction of the zero lines is arbitrary but they are generally laid out in such a way that the line of fire of one of the guns will fall on its correct position on the first target, either directly or after an angle of switch has been given. This gun is known as the pivot gun, and is usually one or other of the flank guns.

ii. *Gun frontage.*

The gun frontage is the distance between the flank guns, normally 45 yards for a platoon. When the line of fire is approximately at right angles to the gun position, which is usual, it can be seen from Figure 19 that the width which is covered by the lines of fire of a platoon on parallel lines is equal to the gun frontage. As the guns are approximately equidistant from one another, the lines of fire of Numbers 2 and 3 guns divide this width into three equal parts, namely, AB, BC, CD.



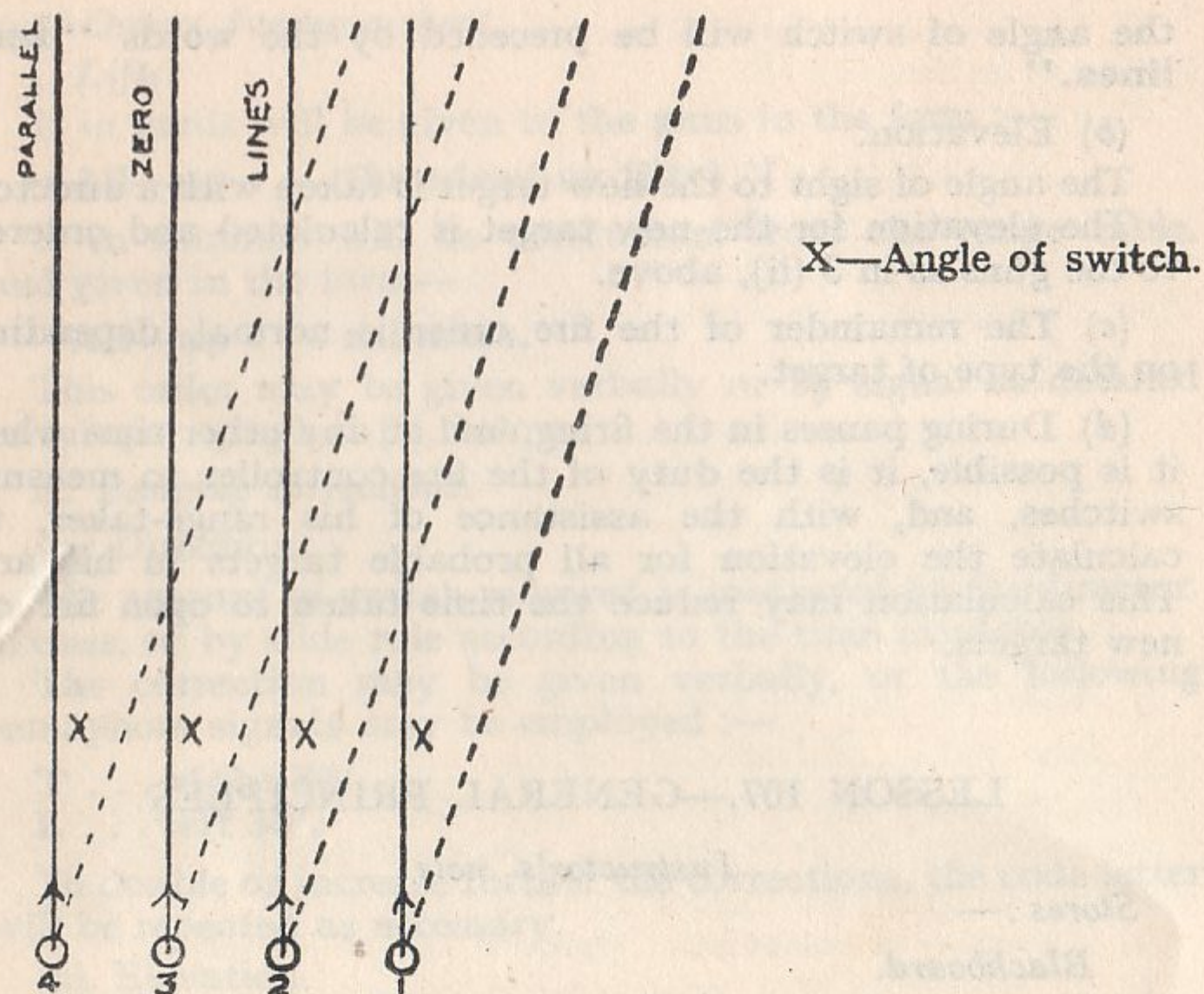


Figure 18

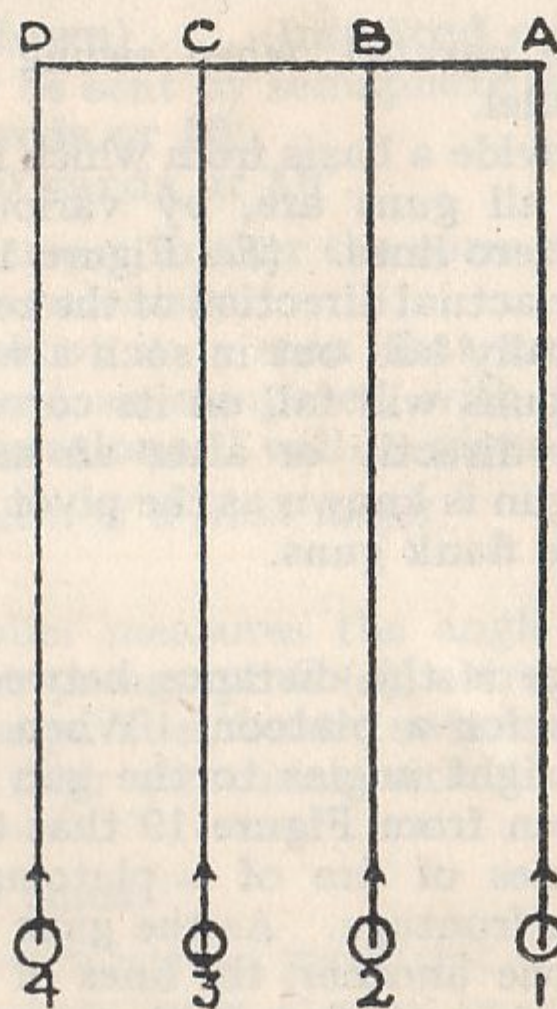


Figure 19

### iii. Dial sight.

As the dial sight is not attached to the gun at the point at which the gun pivots, the dial sight moves in an arc when the gun is swung through an angle.

If this angle is considerable, a corrected angle of switch will be necessary, owing to the altered position of the dial sight.

In order to avoid this, the guns must be mounted in the first instance in the approximate direction of the target. As the angle through which the guns will then be swung will be small and therefore the movement of the dial sight small, the corrected angle can be ignored.

### iv. Errors in range and direction.

Errors in range are allowed for by applying the principle underlying the combined sight rule.

To allow for errors in direction, lines of fire will not be concentrated inside the width covered by parallel lines of fire even for the engagement of a point target. Therefore, in the engagement of point targets, and targets of lesser width than the gun frontage, arrangements are made to bring the target centrally between the parallel lines of fire of the flank guns. The gaps between the guns are covered by tapping right and left one tap, this being sufficient to cause the beaten zones to overlap laterally at all ranges, provided guns are not more than 15 yards apart. It will be noted that additional width is covered in that the flank guns tap outside the gun frontage by one tap.

When the target is of greater width than the gun frontage, guns are first placed on parallel lines with the pivot gun on its own portion of the target. Lines of fire are then either opened out, the gaps between them being filled by tapping right and left, or kept parallel and switched from one portion of the target to another.

2. The various methods employed for the engagement of targets by indirect means may be classified as under :—

- i. Methods employed when the control of fire and the calculations for giving the guns their elevation and direction can be carried out from a position within voice control of the guns. (Voice control methods. Lessons 108-111.)
- ii. When all calculations can be made from a map. (Lesson 120.)



- iii. When the calculations and observations of fire have to be carried out at some distance from the guns. (Lesson 121.)

In all cases it is necessary first to parallel the guns, lines of fire then being opened out to cover the target as necessary. Elevation is obtained by measurement of the angle of sight and the range.

The following sections deal with the theory of the various methods of carrying out these processes.

The details of the necessary fire orders will be found in Lesson 106, and the procedure is given in platoon drill—indirect fire. (Section 18.)

3. Voice control methods are :—

- i. The director method.
- ii. The post method.
- iii. The distant aiming-point and post method.
- iv. The distant aiming-point method.
- v. The crest method.

These methods only differ in the manner in which the guns are placed on their zero lines.

## LESSON 108.—THE DIRECTOR METHOD (DIRECTOR IN FRONT OF OR BEHIND THE GUNS)

### *Instructor's Notes*

*Stores :—*

*Director, two guns with dial sights and tripods, blackboard.*

*Method of instruction :—*

*The theory will first be explained.*

*The guns will then be mounted out of doors. The instructor will choose a target in order that the director can be mounted between the gun position and the target, and will then give individual instruction in the use of the director.*

*When those under instruction are proficient the director will be mounted behind the gun position.*

1. Explain

- i. The director can be employed to parallel the guns when a position can be found for it, either in front of or behind the gun position, from which both the target and the guns can be seen. This position should not be closer than 50 yards to the

guns, nor more distant than approximately 150 yards. It should not be more than 30 yards to a flank.

- ii. The director is used to place the guns on lines parallel to that on which it is itself laid. Therefore the point on the target on which it lays initially will depend on the position of the instrument with reference to the gun position.

For example, consider a target of the same width as the gun frontage. (Lesson 107.)

It is required to bring the line of Number 1 gun on to the right flank of the target ( $T_1$ , Figure 20), and the remaining guns on parallel lines. Suppose that the director is in position at 01.

In order that the zero line of Number 1 gun  $G_1T_1$  should fall on the right flank of the target when placed parallel to the initial line of the director sight, it will be necessary for the director to be laid as much to the left of  $T_1$ , as its position is left of Number 1 gun, that is at X1.

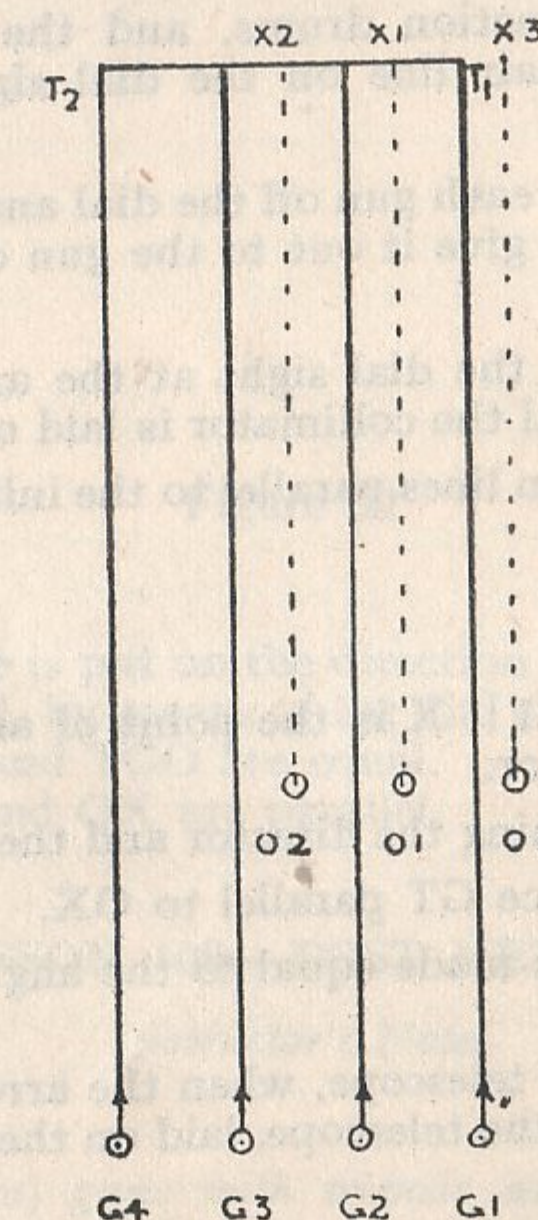


Figure 20.

Similarly, if the director were at 02 in the centre of the gun position, it must be laid at X2 in the centre of the target.



*Explain*

*Procedure.* Two or more posts are aligned on the correct line for the pivot gun. For example, if the width of the target is equal to the gun frontage, and Number 1 is to be the pivot gun, the posts will be aligned on the right flank of the target. They will be so placed that the line joining them passes over the approximate position chosen for that gun. (Figure 22.)

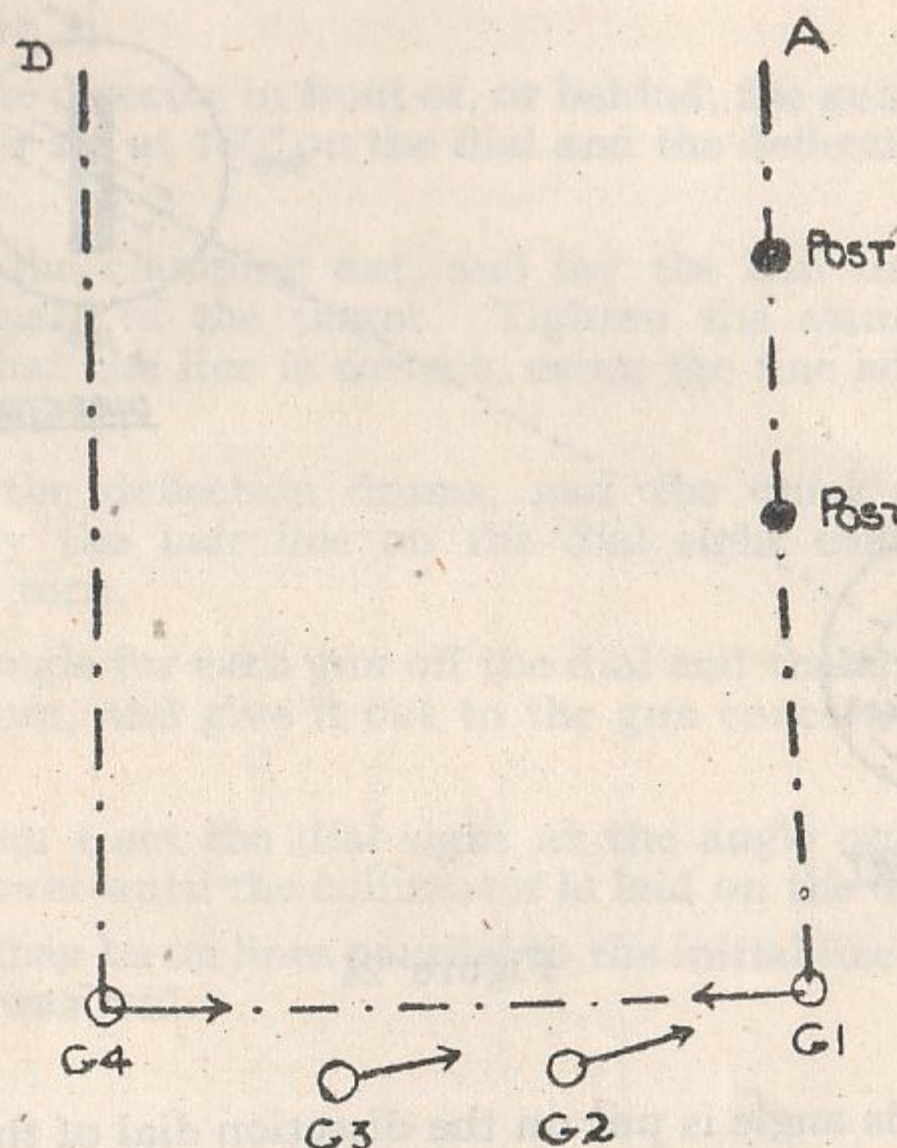


Figure 22

Both posts, or any two, if more than two have been used, must be visible from this position at gun height. When the guns are brought up the pivot gun is mounted in direct alignment with the posts with its dial sight at zero, and the gun is laid on them. It will then be on its zero line.

The remaining guns are so mounted that they have an uninterrupted view of the pivot gun, and can be placed on parallel lines to the pivot gun, as follows:—

- i. The dial sight of the pivot gun is laid on the collimator of the dial sight of each other gun in turn and the angle read out, using the front pointer.

- ii. The other guns put on their dial sights their respective angles as ordered, and then tap their guns until their dial sights are laid on the collimator of the dial sight of the pivot gun.
- iii. When this process is complete, all guns will be parallel and dial sights will then be reset at zero.

# LESSON 110.—A. DISTANT AIMING POINT AND. POSTS METHOD—B. DISTANT AIMING POINT METHOD.

*Instructor's Notes**Stores:—*

*Director, two guns with tripods and dial sights, two zero posts, blackboard.*

*Method of instruction:—*

*The theory will be explained indoors, and the instructor will then give individual practice out of doors.*

*1. Explain*

- i. These methods are a possible alternative when speed is essential and there is a suitable distant aiming point.

They depend on the fact that, when the aiming point is very distant, if the guns are laid on it their lines will be practically parallel.

For example, it can be seen in Figure 23 that the farther away the aiming point is, the more nearly will the guns be parallel on the target  $T_1T_2$ .

The diagram illustrates the worst case where the aiming point is exactly behind the target. In practice, the aiming point may be anywhere with reference to the gun position. When there is a choice, the aiming point lying nearest to a line in prolongation of the gun position will give the best results.

- ii. For this method to be effective certain conditions must be fulfilled:—

- (a) When the aiming point is in prolongation of the gun position it may be as close as 1,000 yards.
- (b) When the line joining the aiming point to the gun position is at an angle of not more than about half a right angle, the aiming point may be as close as 4,000 yards.
- (c) When the line joining the aiming point to the gun position is at a greater angle, the aiming point should be about 7,000 yards distant.



## 2. Procedure

### A. Distant aiming point and posts method.

A director is mounted in direct prolongation of the posts and the angle between the posts and aiming point is measured.

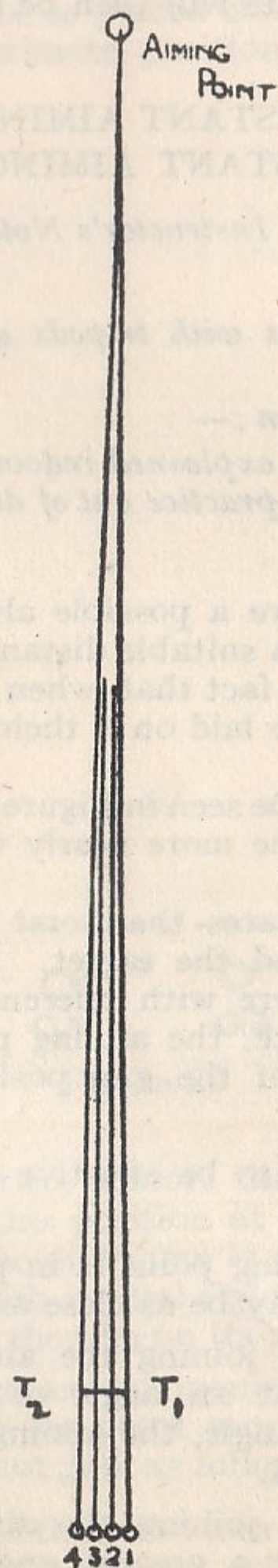


Figure 23

The guns are mounted with the pivot gun approximately over the spot from where the above angle was measured.

This angle is given out as an angle of switch.

All guns put this angle on their dial sights, and are tapped over until their dial sight is laid on the aiming point.

As they have all moved through the same angle off the aiming point they can be regarded as parallel.

### B. Distant aiming point method.

i. Occasionally it may be possible to see both the target and the distant aiming point through a director mounted in the gun position.

#### ii. Procedure.

The angle between the target and the distant aiming point is measured with a director.

This angle is given out as an angle of switch.

All guns set this angle on their dial sights, and are tapped over until their dial sights are laid on the distant aiming point.

## LESSON 111.—CREST METHOD

### Instructor's Notes

#### Stores :—

Two or more guns with tripods and dial sights.

#### Method of instruction :—

The theory will be explained indoors and the instructor will then give individual practice out of doors.

#### 1. Explain

This is a rough-and-ready method for use at ranges not exceeding 1,500 yards, and where observation of strike will probably be obtained.

It can be used when the guns are in action just behind the crest, and the target, although not visible from the gun height, can be seen by the fire controller from any position directly behind the guns up to about 25 yards back.

#### 2. Procedure

The fire controller stands or kneels behind each gun in turn at a convenient distance away. He orders the Number 1 to raise the tangent sight and to lean aside. He then orders him to tap the gun right or left until it is laid on to its correct position on the target.



## LESSON 112.—DISTRIBUTION

*Instructor's Notes**Stores :—*

*Director : range tables and slide rules : two or more guns (with tripods and dial sights).*

*Method of instruction :—*

*The theory will be explained indoors and the instructor will then give individual practice out of doors.*

1. *Explain*

When the width of the target to be engaged is greater than the gun frontage, the parallel lines of the guns may be opened out so that the flank guns are on the flanks of the target, and the remaining guns on points which divide the target into three equal parts.

2. *Procedure*

i. Measure the angle subtended by the target at the observation post. In the voice control methods this can be taken as the same as the angle subtended by the target at the gun position.

ii. From the V.I. graph or slide rule find the angle subtended by the gun frontage at the range to the target, and subtract this angle from the first.

iii. Divide the difference in angle by the number of gun intervals. This will be the angle of distribution.

iv. The gun next to the pivot gun is swung away from the line of the latter by the angle of distribution, the gun two away from the pivot gun by twice the angle of distribution, and the gun on the other flank to the pivot gun by three times the angle of distribution.

*Example :—*

Range to target 1,800 yards.

Angular width of target  $3^{\circ} 50'$ .

Number 4 is pivot gun.

45 yards (gun frontage) subtends  $1^{\circ} 27'$  at 1,800.

$$\begin{array}{r} 3^{\circ} 50' \\ 1^{\circ} 27' \\ \hline \end{array}$$

$$\begin{array}{r} 3) 2^{\circ} 23' \\ \hline 48' \end{array}$$

Distribution—Number 4. Nil.

Number 3. R.  $50'$ .

Number 2. R.  $1^{\circ} 40'$  ( $2 \times 48'$ ).

Number 1. R.  $2^{\circ} 20'$ .

NOTE.—Angles given out to guns to nearest  $10'$ .

NOTE.—Where oblique targets have a different range to each end, the mean range will be used for calculating the angular width of the gun frontage.

3. *Theory*

In Figure 24.

$T_1T_2$  is the target.

Number 1 ( $G_1$ ) is the pivot gun.

$G_2P$ ,  $G_3Q$ ,  $G_4R$  are the zero lines of Numbers 2, 3, and 4 guns.

It is required to place the lines of Numbers 2, 3, and 4 guns at B, C, and  $T_2$ , where B and C divide the target into three equal parts.

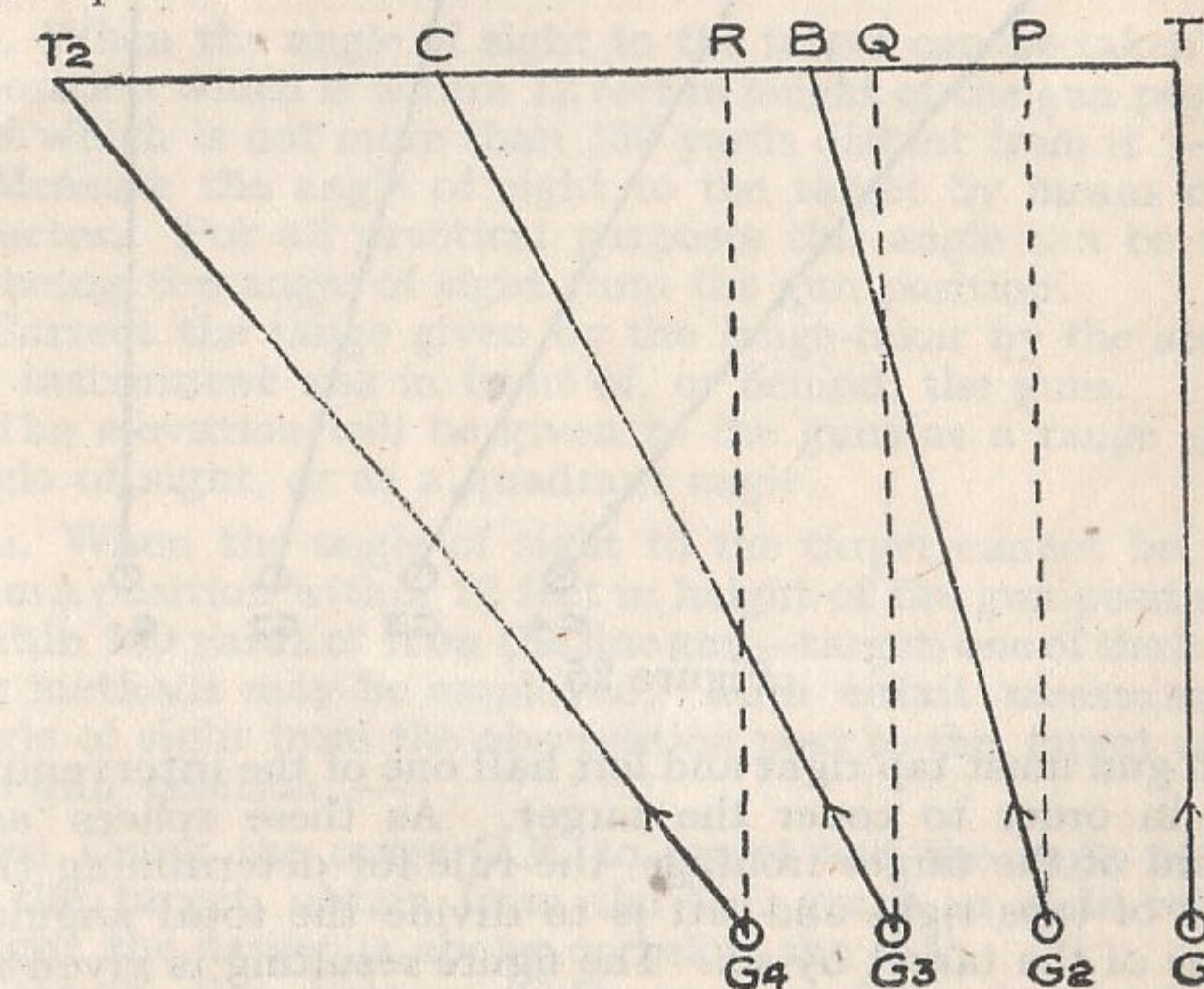


Figure 24

Now P is already one-third of the way along  $T_1R$ . If, therefore, we can switch Number 2 to B, where PB is equal to one-third of  $RT_2$ , B will be one-third along the whole distance  $T_1T_2$ .

Similarly for Number 3 gun, Q is already two-thirds of the way along  $T_1R$ ; to place it at C, therefore, two-thirds of  $RT_2$  must be added to  $T_1Q$ .



Number 4 gun must be moved to the left by the whole amount of  $RT_2$  to bring it on to the left flank of the target.

In the procedure given, by subtracting the angular width of the gun frontage from the angular width of the target, we get the angular width of  $RT_2$ . This divided by three gives the angle of distribution.

4. It can be seen from Figure 25 that when the lines of fire have been opened out four points only,  $T_1$ , B, C, and  $T_2$  are struck by the beaten zones. It is necessary, therefore, to tap right and left in order that the intervening spaces may be engaged.

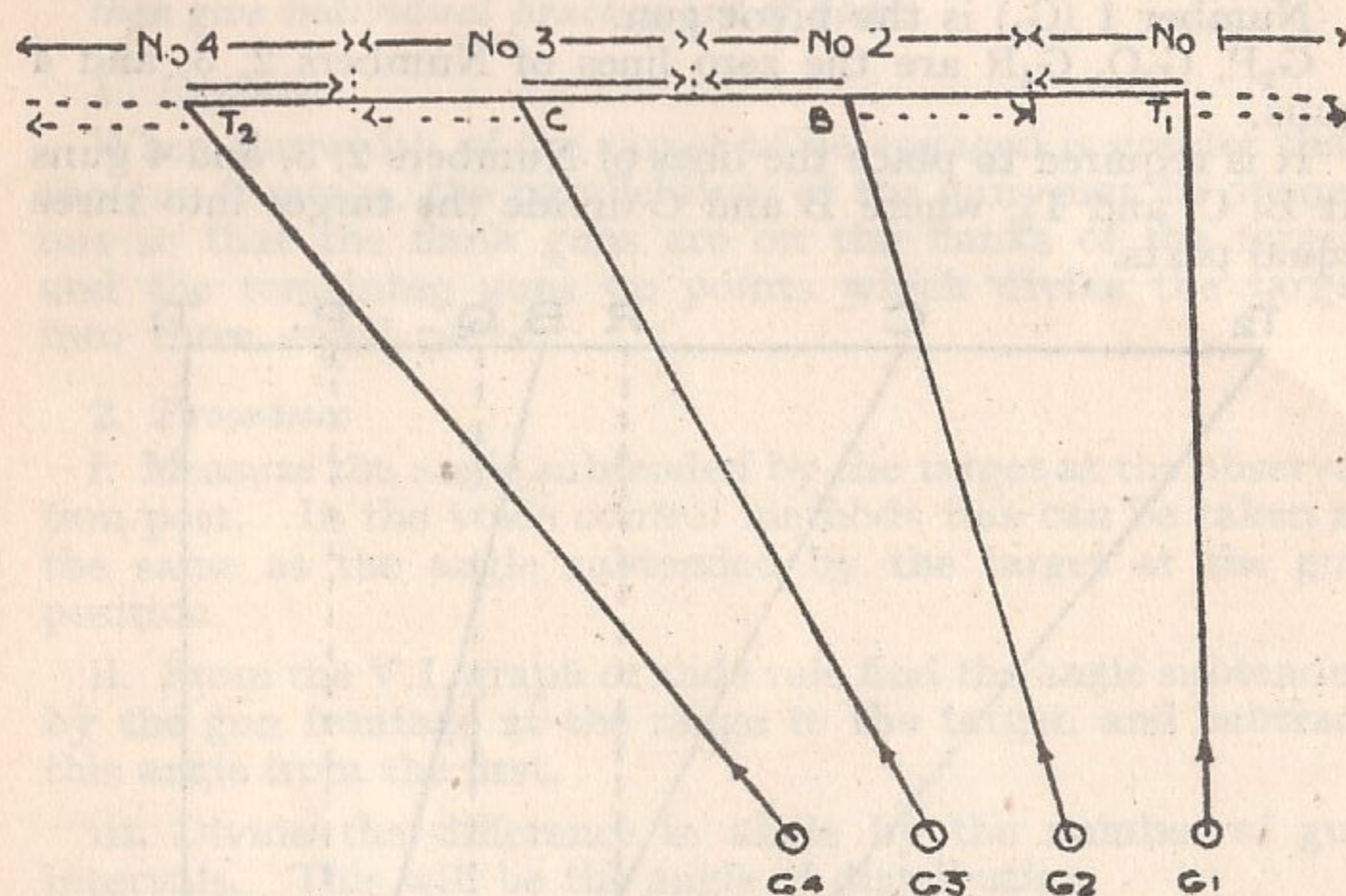


Figure 25

Each gun must tap right and left half one of the intervening spaces in order to cover the target. As these spaces are one-third of the target frontage, the rule for determining the amount of taps right and left is to divide the total angular frontage of the target by six. The figure resulting is given to the guns to the nearest tap. As already stated, the flank guns traverse outside the flanks of the target to allow for errors in direction.

Since one gun cannot engage, with the best effect, more than about 50 yards of frontage, the width  $T_1T_2$  should not exceed about 150 yards.

5. Targets with width greater than the gun frontage can be engaged either by opening out the lines of fire by means of distribution, or by keeping the guns on parallel lines and

switching them from one portion of the target to another. The method employed will depend on the nature of the target and the time available.

## LESSON 113.—OBTAINING ELEVATION

### *Instructor's Notes*

*Stores :—*

*Blackboard, range tables, directors.*

*Method of instruction :—*

*The procedure will be explained indoors. The squad will be practised with examples, and the instruction completed out of doors on various types of targets.*

### 1. Explain

In the voice control methods the elevation is obtained by one of the processes given below :—

i. When the angle of sight to the target can be taken from a position which is within 12 feet in height of the gun position, and which is not more than 150 yards distant from it :—

Measure the angle of sight to the target by means of the director. For all practical purposes this angle can be taken as being the angle of sight from the gun position.

Correct the range given by the range-taker by the amount his instrument was in front of, or behind, the guns.

The elevation will be given to the guns as a range  $\pm$  the angle of sight, or as a quadrant angle.

ii. When the angle of sight to the target cannot be taken from a position within 12 feet in height of the gun position, or within 150 yards of it on the line gun—target, one of the following methods may be employed. Both entail measuring the angle of sight from the observation post to the target and to the gun position :—

(a) Using the range O.P. to target and the angle of sight to the target, obtain from the V.I. graph or slide rule the height the target is above or below the O.P.

Obtain the distance O.P.—gun position by pacing, or estimation, and, using the angle of sight to the gun position, obtain from the V.I. graph or slide rule the height the gun position is below or above the O.P.

A comparison of the heights of the gun position and target above or below the O.P. will give the height the target is above or below the gun position.

Convert this measurement from the V.I. graph or slide rule to an angle of sight.



Example :—

Angle of sight from O.P. to target—depression 22'.

Angle of sight from O.P. to gun position—depression 2° 20'.

Range O.P.—target, 1,700 yards.

Distance O.P.—gun position, 80 yards.

Range gun position—target, 1,750 yards.

Target is below O.P.—11 yards. (The amount subtended by 22' at 1,700 yards.)

Gun position is below O.P.—3 yards. (The amount subtended by 2° 20' at 80 yards.)

Therefore target is below gun position eight yards.

From V.I. graph or slide rule angle of sight (eight yards at 1,750 yards)=depression 15'.

(b) Obtain the angle of sight gun position—target from the following formula and calculate the Q.A. as in sub-paragraph i., above :—

$$\begin{array}{l} \text{Angle of sight} \\ \text{from gun position} \\ \text{in minutes} \end{array} = \frac{(a_1 \times GO) + (a_2 \times OT)}{GT}$$

Where T is the target, O the position of the director and G the gun position, and where

$a_1$  is the angle of sight from G to O in minutes.

$a_2$  is the angle of sight from O to T in minutes.

$a_1$  and  $a_2$  must be provided with the correct signs before being placed in the formula, i.e. plus for angles of elevation, minus for angles of depression.

Example :—

Angles of sight are measured by director :—

To target—depression 5'.

To pivot gun—depression 3°.

The angle of sight from G to O is opposite in sign to that from O to G, and is therefore elevation 3°.

OT = 1,900 yards, OG = 150 yards, GT = 2,000 yards.

The required angle of sight in minutes.

$$180 \times 150 + (-5 \times 1,900)$$

$$= \frac{\quad}{2,000}$$

$$18 \times 15 - 5 \times 19$$

$$= \frac{\quad}{20}$$

$$\frac{270 - 95}{20} = \frac{175}{20}$$

$$= + \frac{175}{20} = \text{approx. } 9' \text{ elevation.}$$

Angle of sight = 9' elevation.

2. The target may have a different range to each end, and possibly also a different angle of sight. In this event the elevation must be calculated for each end of the target, which will give the elevations for the flank guns. The difference between these two elevations divided by three (the number of gun intervals) will give the increase or decrease in elevation required between adjacent guns.

For example :—

Number 1 gun. Range 1,500, A. of S. + 30'.

Number 4 gun. Range 1,350, A. of S. Nil.

The elevations for remaining guns will be :—

Number 2. Range 1,450. A. of S. + 20'.

Number 3. Range 1,400. A. of S. + 10'.

3. In the application of the combined sight principle to indirect fire, the fact that the guns are either on parallel lines or distributed, means that they must all be given the same lifts (up or down) together.

Thus, when engaging a point target at 2,200 yards (range-finder) with an angle of sight from gun to target of plus 20' (no wind), the successive orders for elevation would be :—

Opening elevation ...	All 2,200 + 20'	or All 4° 20'.
2nd " ...	All down 50	or All down 10'.
(The lift for 50 at 2,200.)		
3rd " ...	All up 100	or All up 20'.
4th " ...	All down 150	or All down 30'.
5th " ...	All up 200	or All up 40'.

The "quadrant elevation" method of giving the elevation is preferable for point targets, and targets with width.

The "quadrant angle" method is preferable for targets with depth and area targets (see Section 30, Example 6).

## LESSON 114.—CREST CLEARANCE

### *Instructor's Notes*

*Stores :—*

*Blackboard, range tables, director, gun and tripod with dial sight.*

*Method of instruction :—*

*The procedure will be explained indoors. The squad will be practised with examples and the instructions completed out of doors on various types of targets.*



1. *Explain*

The initial responsibility for determining whether the bullets will clear the crest in front of the guns rests with the fire controller. He must ensure that, when he chooses the gun position, clearance exists for the target or targets he intends to engage.

It will not always be necessary or practicable to resort to measurement by instruments and calculation of crest clearance during the reconnaissance for the gun position. With practice it may often be possible to judge how far back the gun position can be situated without risk of the bullets striking the crest.

If, however, the range is short and the slope steep, it will be necessary to check the clearance as outlined below before the gun position is decided on and the guns are brought up.

The subsequent responsibility will rest with the N.C.O. in charge of the gun position. He must ensure that after the guns have been laid initially for direction and elevation, no gun is fired unless the bullets will clear.

Further, he must, at the first opportunity, ascertain the lowest quadrant angle at which the crest can be cleared and report it to the fire controller.

Calculations should always be made with reference to the highest point over which the guns may be called upon to fire.

The procedure for ascertaining the minimum quadrant angle either before or after the guns have occupied the position, and for checking whether the bullets will clear the crest after the guns have been given their initial line and elevation, is given below.

## 2. To ascertain the minimum quadrant angle.

Theory :

To ensure that the lowest shot of the cone clears the crest the following factors must be allowed for :—

- i. The tangent angle for the range to the crest plus the possible error in determining the range.
- ii. The height of the centre shot above the lowest shot.
- iii. The angle of sight from the gun to the crest.

The sum of i and ii is known as the "Crest Clearance Angle" and is given for each range in the range table.

Procedure :

(a) Estimate the range from the gun position to the crest or take it by range-finder. Look up the crest clearance angle for that range.

(b) Using the director at gun height, or a gun, at the lowest part of the gun position in relation to the crest, measure the angle of sight to the crest. When using a gun this measurement is carried out as follows :—

Set the tangent sight at zero and lay at the highest point of the crest over which the guns may be called upon to fire. Affix the dial sight with range and elevation drums at zero, and level the bubble, using the angle of sight drum. Read the angle of sight from the drum. By adding the crest clearance angle to this figure the minimum quadrant angle is obtained.

3. To ascertain, after the guns have been laid for elevation and direction, whether the crest will be cleared.

- i. If the range to the crest is *not* more than 200 yards :—  
Set the tangent sight at 400 yards. If the line of sight clears the crest, the bullets will clear.
- ii. If the range to the crest is more than 200 yards :—Add 200 yards to the range to the crest. Place the resultant range on the tangent sight. If the line of sight clears the crest, the bullets will clear.
- iii. If a downward correction is ordered, the Numbers 1 will automatically check for crest clearance.

## LESSON 115.—ANGLE OF SWITCH

*Instructor's Notes*

*Stores required :—*

*Blackboard, one gun and tripod, dial sight, aiming post, director, slide rule, range tables, and field plotter.*

*The subject matter will be given in the form of a lecture.*

1. *Explain*

In each of the following diagrams :—

- G = pivot gun, or gun nearest to the director.
- O = position of director.
- T = first target.
- GT = zero line on to first target.
- X = fresh target.

2. It is not true to say that the angle of switch between T and X measured from O is for practical purposes equal to the angle of switch GT to GX. The error may be so great that all four guns will miss the fresh target. The size of the error varies with the distance that O is in front of or behind the



pivot gun. In every case it is necessary to find the angle  $TGX$  as accurately as possible.

3. On occasions it may be possible to mount the director over the position of the pivot gun or within a few yards of it, in which event we can, for practical purposes, regard the angle  $TOX$  as being the same as the angle  $TGX$ , and give it to the guns.

4. If the director cannot be mounted over the position of the pivot gun, but can be mounted either within the zero lines (in front of or behind the gun line) or displaced by not more than 30 yards to either flank, proceed as follows (see Figs. 26 and 27) :—

From  $O$  measure the angle  $TOX$  and convert that angle to yards at range  $OX$ . Convert those yards back to an angle at the range  $GX$ . The answer will be the angle  $TGX$ ; i.e. the switch to bring the pivot gun from  $GT$  to  $GX$ .

(NOTE.—The switch will be given out to the nearest 10 minutes.)

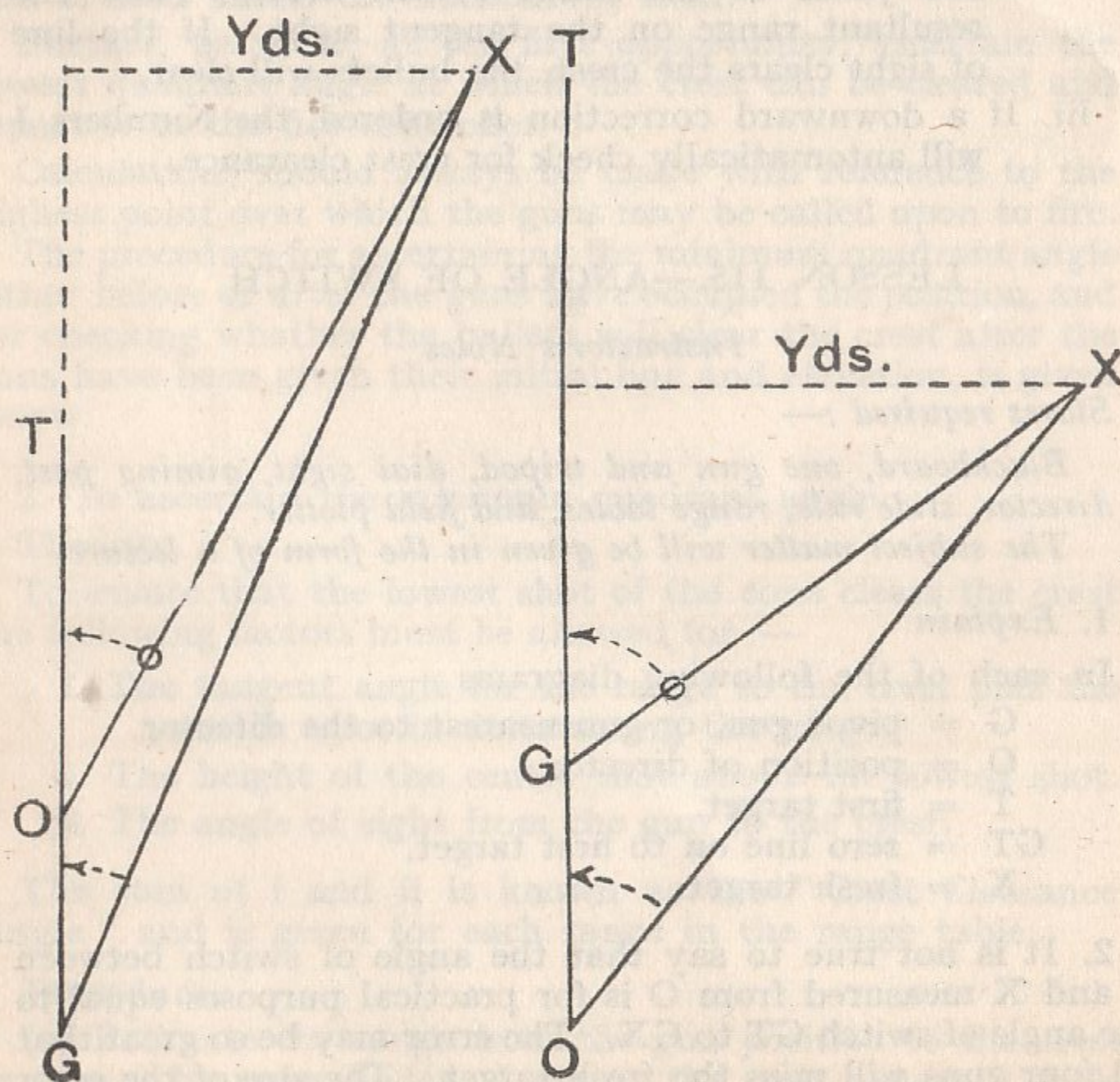


Figure 26

Figure 27

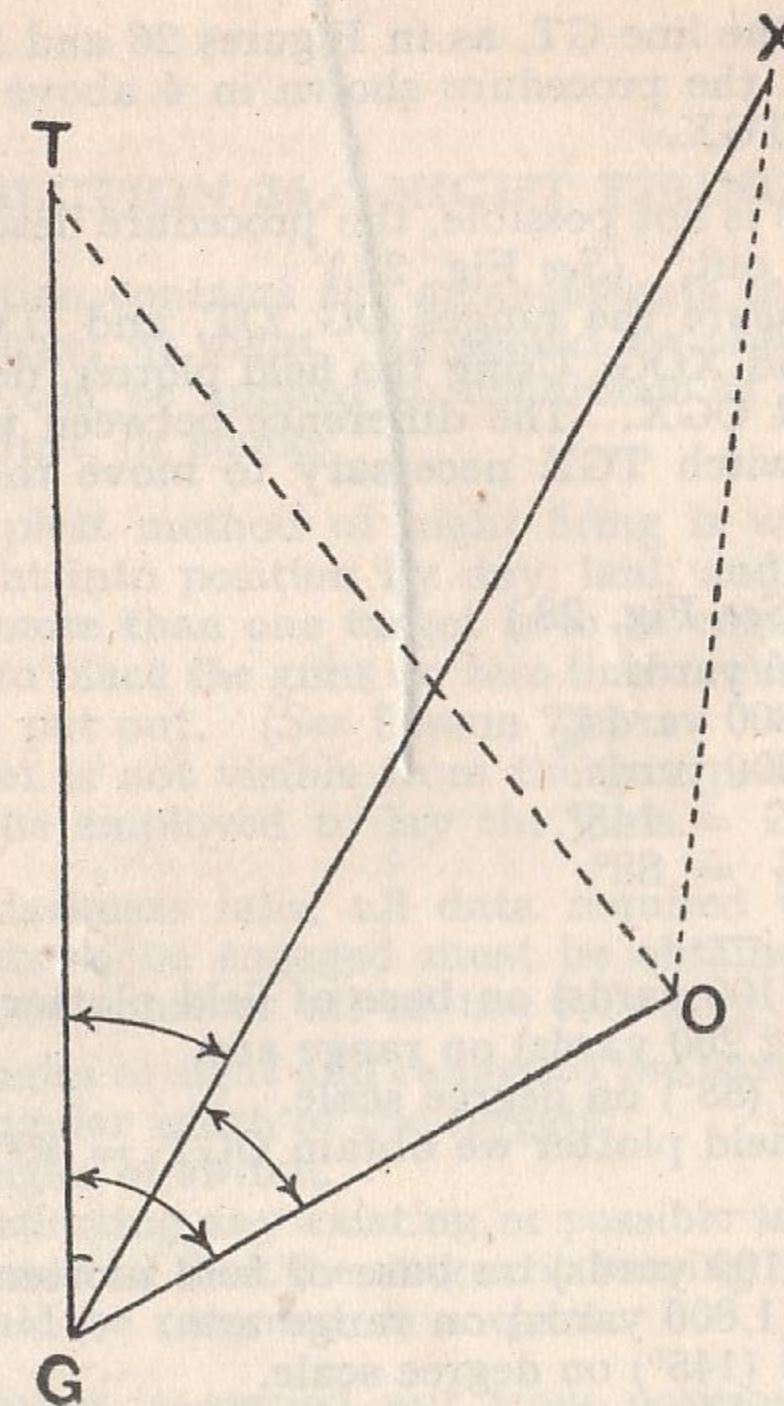


Figure 28

Example. (See Figure 27.)

With the director at  $O$  the angle  $TOX$  has been measured to be  $8^\circ$ .

Range  $OX = 2,000$  yards.  $8^\circ$  at 2,000 yards subtends 280 yards.

Range  $GX = 1,850$  yards. 280 yards at 1850 yards subtends an angle of  $8^\circ 40'$ .

Therefore angle of switch to bring pivot gun to  $X$  from  $T = 8^\circ 40'$ .

(NOTE.—When working out a switch, work on the range to the fresh target.)

5. When  $O$  is displaced by more than 30 yards, it may be possible for the fire controller, or some other person who knows both the zero lines and the fresh target, to move to a



position O on the line GT, as in Figures 26 and 27. He will then carry out the procedure shown in 4 above in order to find the angle TGX.

6. When this is not possible, the procedure described below will be carried out. (See Fig. 28.)

From O measure the ranges OG, OT, and OX; also the angles TOG and XOG. Using the field plotter, determine the angle OGT and OGX. The difference between these will be the angle of switch TGX necessary to move the pivot gun from T to X.

Example. (See Fig. 28.)

OG = 100 yards.

OX = 1,800 yards.

OT = 2,200 yards.

Angle XOG =  $145^\circ$ .

Angle TOG =  $88^\circ$ .

To find OGT :—

Place OG (100 yards) on base of field plotter.

Place OT (2,200 yards) on range arm.

Place TOG ( $88^\circ$ ) on degree scale.

From the field plotter we obtain OGT =  $89^\circ 30'$ .

To find OGX :—

Place OG (100 yards) on base of field plotter.

Place OX (1,800 yards) on range arm.

Place XOG ( $145^\circ$ ) on degree scale.

From the field plotter we obtain OGX =  $33^\circ 20'$ .

The angle of switch to bring the line of fire of the pivot gun from T to X can be found by subtracting OGX ( $33^\circ 20'$ ) from OGT ( $89^\circ 30'$ ).

\* \* angle of switch TGX =  $56^\circ 10'$ .

7. Practise squad out of doors.

## SECTION 26.—NIGHT FIRING

1. This section contains the arrangements to be made for engaging a target at night. It should be noted that these arrangements can be applied to conditions of bad visibility such as fog, dust, or smoke.

2. The simplest method of night firing is when the guns can be brought into position by day, laid, and aiming posts planted. If more than one target is to be engaged, it would be necessary to place the guns on zero lines. At dusk, aiming lamps will be put out. (See Lesson 7.)

If the target is not visible from the gun position, indirect means must be employed to lay the guns.

3. Before darkness falls, all data required to enable the various targets to be engaged must be obtained.

These include some or all of the following :—

The angles of sight and ranges to the various targets.

The angular width of the targets.

The angles of switch.

Data affecting any existing or possible safety problem.

It is essential that the magnetic bearing of the zero line should be recorded as a check.

4. When firing is carried out from positions behind the forward localities, special precautions, such as posting sentries or wiring the danger area, must be taken to ensure the safety of our own troops when passing near the gun positions.

## LESSON 116.—RECONNAISSANCE BY DAY

### Instructor's Notes

Stores :—

Gun pegs, direction pegs, zero posts, director, slide rules, and range tables. *Guns 2nd direction Pegs*

Method of instruction :— *will be improved*  
A simple tactical situation will be defined and the procedure explained. The squad will practise putting out pegs both in front and in rear of the gun position.

Explain

It is necessary to put out direction pegs and zero posts for each gun on zero lines, in order that the guns can be switched



from the zero line to fresh targets. The direction pegs and zero posts may be in front of or behind the gun pegs.

Reconnoitre for the gun positions, and place in a gun peg to mark each position.

A zero line is selected. A target may make a suitable zero line, or, should the arc be a wide one, some point in the centre of the probable target area.

A direction peg for the pivot gun is placed in direct alignment of the gun peg and the zero line.

Place a zero post accurately in line with, and between, the gun peg and direction peg.

1. Both direction peg and zero post will be put in by using a director.

The direction peg should be about 20 to 30 yards from the gun peg and the zero post, and in such a position that it will be silhouetted against a lamp held behind the direction peg.

Where a D.A.P. is available (Lesson 110), measure with a director the angle between the D.A.P. and the zero line for the pivot gun. Mount the director in turn over the remaining gun pegs, lay this angle off the D.A.P., and place the direction peg and zero post on this line.

Where no D.A.P. is available the following method may be adopted. The procedure is described for two guns only, but can be extended to include four guns if required:—

Put out gun pegs for each gun ( $G_1G_2$ ) (Figure 28). 28

Place a direction peg ( $P_1$ ) and zero post ( $Z_1$ ) on the zero line for the pivot gun, either in front of or behind the gun position.

Measure the distance between the gun pegs ( $G_1G_2$ ).

By means of the V.I. graph or slide rule calculate the angle  $G_1T_1G_2$ , i.e. the angle subtended at the range  $G_1T_1$  by the distance  $G_1G_2$ .

Set up the director over the other gun peg ( $G_2$ ) and lay it on  $T_1$ , with the arrow at  $0^\circ$ . Lay off the angle found above, right or left as required (left in case shown), and place a direction peg ( $P_2$ ) and zero post ( $Z_2$ ) on this line.

2. To avoid exposing personnel in front of the gun position, it may often be desirable to place the direction pegs and zero posts in rear of the gun pegs. In this event it may be necessary to screen the aiming lamps from the front when giving direction to the guns.

When the guns are brought up the procedure is as described in section drill—night firing (Section 19).

3. On occasions it may be necessary to place out the posts and pegs to a flank of the zero line. On such occasions the angle of switch from the posts to the zero line will be recorded.

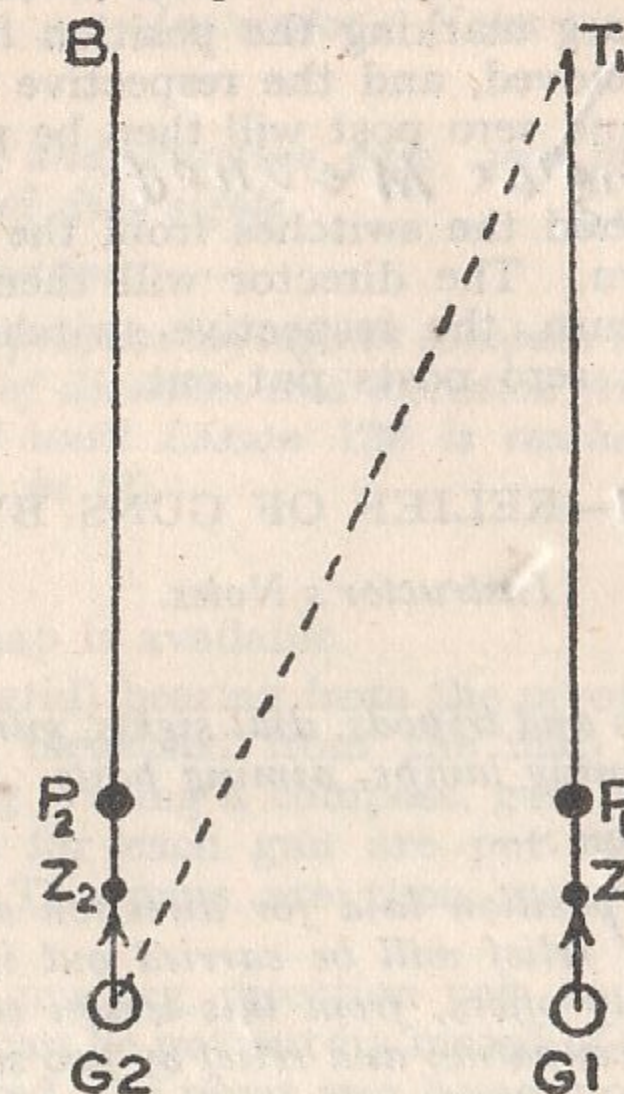


Figure 28

## LESSON 117—RECONNAISSANCE BY DAY (INDIRECT FIRE)

### Instructor's Notes

Stores:—

As for Lesson 116.

Method of instruction:—

Instruction will be developed from Lesson 116 to include the observation post.

Explain

When the targets are not visible from the gun position to be occupied, but are visible from an observation post within voice control of the gun position, the following will be the procedure:—

Gun pegs are put out for each gun. Direction pegs and zero posts on parallel zero lines are then placed in position by any of the indirect means already described.



If the director method is employed, the switches will be noted down and the position of the director marked with a peg. The director will then be moved to each gun peg in turn, laid on the peg marking the position from which the director has been moved, and the respective switch put on, the direction peg and zero post will then be put out on this line.

*Gun & Peg Method*  
In the post method the switches from the pivot gun peg will be noted down. The director will then be moved to each gun peg in turn, the respective switches put on and direction pegs and zero posts put out.

## LESSON 118—RELIEF OF GUNS BY NIGHT

### *Instructor's Notes.*

#### *Stores :—*

*Two or more guns and tripods, dial sights, gun pegs, direction pegs, zero posts, aiming lamps, aiming posts.*

#### *Method of instruction :—*

*Guns will be in position laid for direction and elevation.*

*The procedure of relief will be carried out in detail.*

*Where opportunity offers, from this lesson can be developed the full process of occupation and relief by two separate sections.*

#### *Explain*

1. The collimator on the gun to be relieved will be zeroed. The angle to the aiming lamp will then be measured and handed over to the non-commissioned officer in charge of the relieving gun.

2. The non-commissioned officer in charge of the relieving gun will supervise a gun peg being placed accurately under the socket of the gun to be relieved. To do this the gun and cross head will be removed.

3. The gun to be relieved will then be removed; the relieving gun being mounted accurately over the gun peg.

4. The angle measured in (1) above will be set on the dial sight of the relieving gun, and the gun then tapped until the collimator is aligned on to the aiming lamp of the section being relieved. The relieving gun is then laid for direction.

5. When both guns in the relieving section are laid for direction, this aiming lamp will be removed. The relieving section will then put out its own aiming lamp, the further procedure being as in section drill. (Night firing (Section 19).)

## LESSON 119.—WHEN THE GUN POSITION CANNOT BE REACHED BY DAY

### *Instructor's Notes*

#### *Stores :—*

*Compass, gun and direction pegs, zero posts, one (or more) guns, tripods and dial sights.*

#### *Method of instruction :—*

*The class will practise laying out compass lines from gun pegs. The measuring of direction and elevation from the map should not be practised until Lesson 120 is reached. The class will then practise as in (2).*

#### *Explain*

1. When a map is available.

The true (or grid) bearing from the pivot gun to the target or zero line is measured from the map and converted to compass bearing; using a compass, gun pegs, direction pegs and zero posts for each gun are put out on this bearing (Lesson 120). The guns are then mounted over the gun pegs.

If desired, a gun peg, direction peg, and zero post for the pivot gun only can be put out by means of the compass. The guns are mounted, the pivot gun being mounted over its gun peg and given direction. The remaining guns are then placed on parallel lines by the post method (Lesson 109). The point of aim for each gun must be illuminated.

When using either of the above methods great accuracy cannot be expected.

2. When no map is available.

If circumstances allow of a light being shown on the spot where it is desired that the fire should fall, arrangements can be made to fire on a fixed line at short range with fair accuracy.

The procedure is described in Lesson 129.



## SECTION 27.—MAP SHOOTING

1. Accurate shooting from the map is only possible when a map scale 1/25,000 or larger is available. Where accuracy is not essential, for example, for the engagement of areas well removed from the position of our own troops, maps of smaller scale should not be ignored, but it should be noted that the detail on such maps is not usually "surveyed in."

2. The principle of map shooting is that all calculations, both for direction and elevation, are made from the map.

The method has certain definite advantages, namely :—

No observation post is necessary.

Targets can be engaged which cannot be seen from the ground.

Preparations to open fire can be made before the actual targets have been located.

Any number of targets can be engaged by switches.

It is just as flexible by night as by day.

It also has certain disadvantages, namely :—

1/25,000 maps are not always available.

Maps are liable to distortion. (This difficulty can be overcome).

Accurate location of points on the map is often difficult.

Corrections by observation of fire are not possible—there being no O.P.

3. The method entails :—

i. Location of guns on the ground, and marking in the position of the pivot gun on the map.

ii. Laying out the zero line for each gun.

iii. Location of target or targets on the map, and calculating data required to hit them.

The processes i and ii must be carried out in daylight, though the guns themselves need not be brought into action until after dark. Therefore orders for a map shoot to be carried out at night must reach the platoons concerned in sufficient time before dark.

4. The position of the pivot gun can be fixed on the map, either :—

i. By resection ; using one of the following methods :

(a) Resector protractor. (See Small Arms Training, Volume I, Pamphlet 7, Part I. Lesson 41, paragraph B).

(b) ~~Tracing paper.~~

(c) Compass.

ii. By comparing the detail on the ground with the detail on the map.

5. The most common method is that mentioned at i (a) above, and is carried out as follows :—

*Resection by resector protractor :—*

i. From selected position for pivot gun locate three objects visible on the ground which can be identified on the map.

(For the best results, these points should be so selected that the angle subtended by any two of them at the gun is not less than 90°).

ii. Mount a director over the pivot gun position (with all dials at zero) and lay on one of these points.

iii. Measure the angle to each of the other points in turn.

iv. Set these angles on the resector protractor by moving the pivoting arms ; clamp up.

v. Place the resector on the map and move it about until the bevelled edges of the arms pass through the points on the map. The position of the pivot gun will then be in the centre of the pencil hole, and should be marked in on the map with a sharp-pointed pencil.

NOTE.—When no director or dial sight is available, the above angles can be measured by taking bearings to the points selected, subtracting one from the other.

6. When for some reason a resector protractor is not available, the above type of resection can be carried off with tracing paper as follows :—

*Resection by tracing paper.*

i. Proceed as described in paragraph 5 i, ii, and iii above.

ii. On a good sized sheet of tracing paper, draw a straight line, and mark a point of origin at one end of it.

iii. From the point of origin, using a protractor, draw in two further lines, making the angles between these two lines and the original line equal to those measured by the director.



- iv. Write alongside each line the name of the point to which the angles were measured by the director. (This will save confusion when moving the tracing paper about the map).
- v. Place the tracing paper on the map, and move it about until the lines pass through the selected points on the map.
- vi. By inserting a pin or a sharp pencil through the point of origin, mark on the map the position of the pivot gun.

#### 7. Resection for compass.

For details of method (c) see Manual of Map Reading, Photo Reading and Field Sketching, 1929, Section 141.

8. Where time permits, greater accuracy is obtained by employing one method and checking with another.

It may be possible to obtain the aid of a survey unit where a very accurate location is necessary.

### LESSON 120.—SHOOTING FROM THE MAP

#### *Instructor's Notes*

*Stores : Map (minimum scale 1/25,000), protractor, compass, gun and direction pegs, zero posts, director, range table.*

*Method of instruction :—*

*The class will be instructed in measuring angles and bearings on the map and will then work out problems of elevation, distribution, crest clearance, and safety. The class will practise out of doors the location of the pivot gun, both by resection and local detail.*

*Explain*

#### 1. Direction

i. A zero line is chosen in the centre of the target area or, if the targets are not known, in the most suitable direction. This line is represented by the line GZ in Figure 30. (Z need not be visible from the gun position.)

Two methods may be employed for placing the guns on their zero lines :—

(a) By means of a reference point.

(b) By compass.

#### ii. By reference point

A reference point which is both marked on the map and visible from the pivot gun is selected. (See Figure 30.)

The zero line of the pivot gun is drawn on the map (GZ).

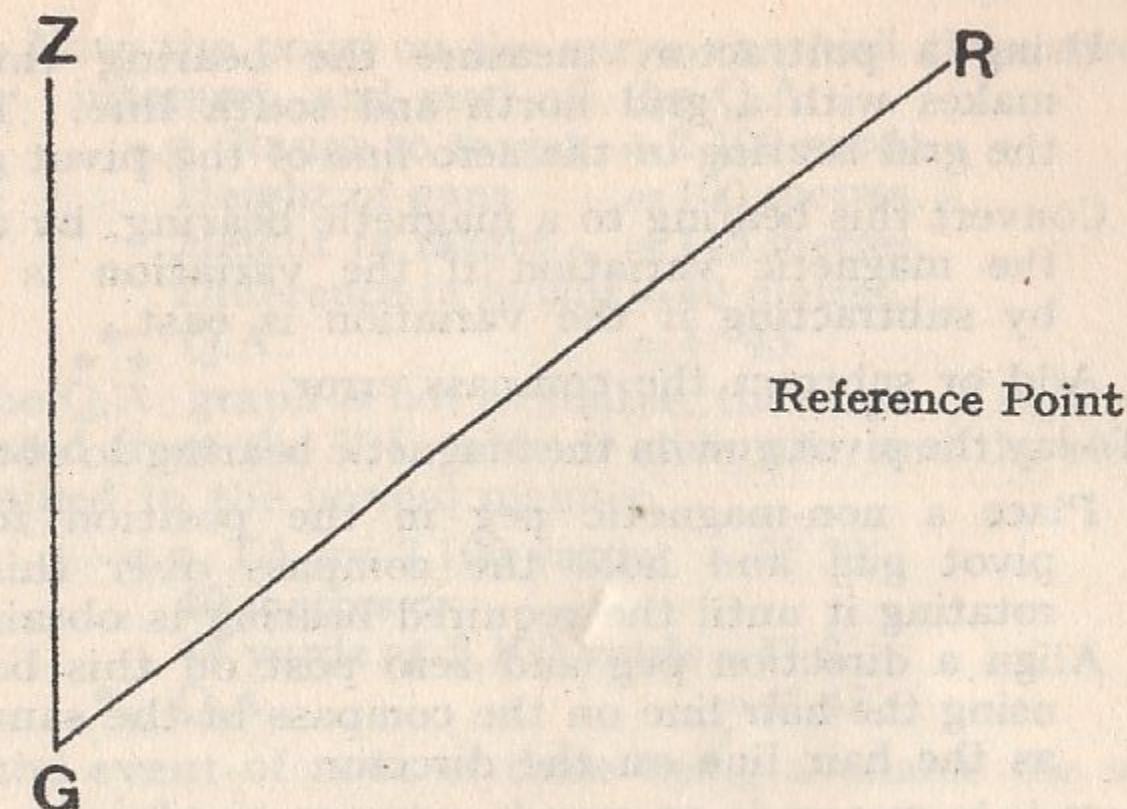


Figure 30

The line joining the pivot gun to the reference point is also drawn in (GR).

The angle RGZ is measured with a protractor.

If the guns are in position :—

This angle is set on the dial sight of the pivot gun, which is tapped over until the dial sight is laid on the reference point. The remaining guns are paralleled by the most suitable method.

If R conforms to the requirements of a D.A.P., all guns swing through the angle RGZ.

If the guns are not in position :—

Mark the point G with a gun peg.

Mount a director centrally over it, and swing through the angle RGZ.

Place a direction peg and zero post on the line GZ a suitable distance from the gun peg.

Mark the positions for the remaining three guns with gun pegs.

Place direction pegs and zero posts for each gun on lines parallel to GZ, by any of the methods described in Lessons 108 and 109.

iii. *By compass.* (Should only be used when no daylight reconnaissance is possible, or when there is no suitable reference point.)

iv. The magnetic bearing of the target from the pivot gun must be found.

To find this bearing :—

(a) Draw a line on the map, along the zero line of the pivot gun.



- (b) Using a protractor, measure the bearing this line makes with a grid north and south line. This is the grid bearing of the zero line of the pivot gun.
- (c) Convert this bearing to a magnetic bearing, by adding the magnetic variation if the variation is west; by subtracting if the variation is east.
- (d) Add or subtract the compass error from the bearing so obtained.
- v. To lay the pivot gun on the map, proceed as follows:
- (a) Place a non-magnetic peg in the position for the pivot gun and hold the resector over this peg, rotating it until the bearing is obtained.
- (b) Align a direction peg on the map, passing in the same way as the hair line on the resector.
- (c) To parallel the resector, proceed as for the post method, but by using a compass for each gun.

## 2. Elevation

The range GT is calculated from the map. There are, however, difficulties to be overcome when making this measurement.

They are the possibilities of map distortion, and the accurate location of the target on the map.

Two methods are available for use:—

- i. By measurement
- ii. By calculation

When using the scale, the range may be measured by the scale on the resector, using the arm corresponding to the scale of the map, or by using dividers in conjunction with the scale on the map.

For method see Small Arms Training, Volume I, Pamphlet 7, Part 1, Lesson 41, 1, iii.

When using this method any distortion is overcome.

## 3. Angle of sight

Examine the contours and note the height of the guns and the target; and thus determine the difference in height between the two.

Now refer to the Q.A. graph in the range tables:—

- i. Follow down the vertical line at the range to the target, and note where it cuts the horizontal line at the height that T is above or below G.

- ii. Note the point on the curve at which these two lines intersect, and read off the Q.A.

e.g. Range to target = 2,100 yards.

Height of guns = 100 metres.

Height of target = 140 metres.

Difference in height = 40 metres.

\* \* Q.A. = 4° 45'.

If the Q.A. graph is not available, the angle of sight can be calculated from the V.I. table or slide rule, and the elevation determined in the normal manner.

e.g. TA for 2,100 yards = 3° 39'.

40 metres or

44 yards at 2,100 yards = 1° 6'.

\* \* Q.A. = 4° 45'.

In the event of none of these being available the scale of angles of sight in minutes shown on the arms of the resector protractor may be used.

## 4. Distribution

On the map, join the position of the pivot gun and the two ends of the target.

Measure the angle thus formed at the pivot gun and work out distribution as for indirect fire.

## 5. Crest clearance

It may be necessary to ascertain whether the bullets will clear an obstruction which is not visible from the gun position.

Draw a line on the map between gun position and target, and see if this line passes through a contour higher than the gun position. If a crest is found to be in the line of fire the procedure will be as follows:—

- i. Measure the range to the crest.
- ii. From comparison of the contours find out by what amount the worst part of the crest is above the guns.
- iii. Add to this the lower half of the cone of fire at the range to the crest.
- iv. Using the Q.A. graph—

Find the horizontal line for the height of the crest plus the lower half of the cone. Find the point at which this cuts the vertical line at the range to the crest. Note the nearest curve to the point of intersection.

This gives you the M.Q.A. to clear the crest; and the lowest Q.A. to hit the target must be equal to or greater than this M.Q.A.

e.g. (Taking the case of the previous example)

Range to crest: 500 yards.



Crest : 20 metres above guns.

Lower half of the cone of fire at 500 yards = 1 metre.

At the intersection of the 500 yards and 21 metres lines is found the 3° curve. This is the M.Q.A.

Q.A. to hit target = 4° 45'.

\*\* Guns will clear crest.

#### 6. Safety calculated from the map

i. Ascertain from the contours the highest point on which own troops are located, and over which there is a possibility of fire being directed. Subtract from this height the height of the gun position; this gives the height of the crest (on which the troops are) above the gun position.

ii. Add to this height the minimum clearance required at the range to our troops. From the Q.A. graph determine whether the trajectory curve for the lowest Q.A. for the target clears this height at the range to our troops.

e.g.—

	Range	Contour level
Gun position ...	—	105 metres.
Target ...	2,500 yards	120 metres.
Own troops ...	1 000 yards	145 metres.

Target is 15 metres above the gun, therefore Q.A. required is 5°. (Taken from Q.A. graph, using a range of 2,400.) Our troops are 40 metres above the gun.

The minimum clearance is 17 metres (from Q.A. graph, at bottom) at 1,000 yards.

Therefore total clearance required = 57 metres.

The 5° curve gives a clearance of 63 metres at 1,000 yards, therefore our troops are safe.

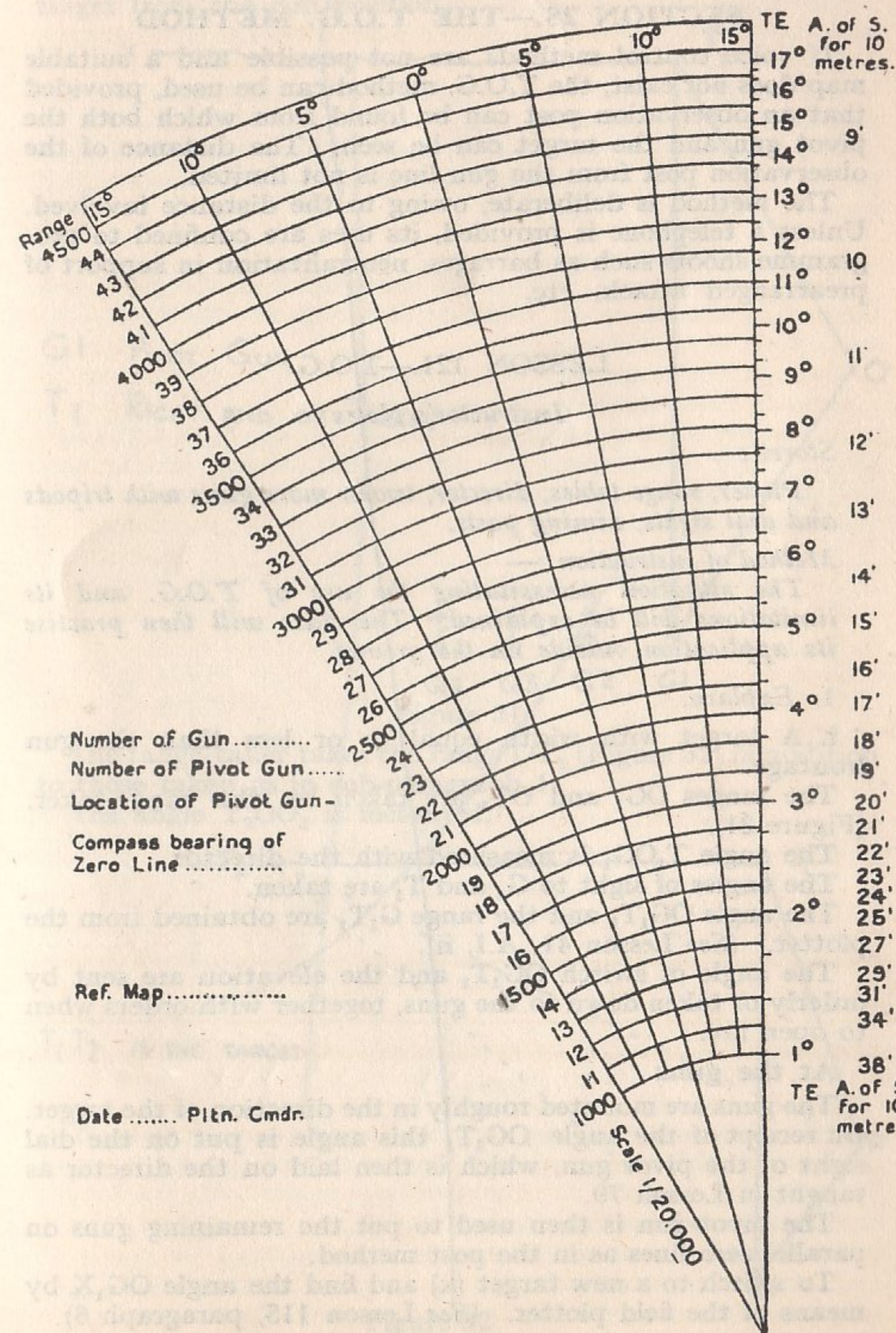
#### 7. Fighting map

When a position is to be occupied for some time, and maps of sufficiently large scale for accurate shooting are available, steps should be taken to prepare a fighting map, so that new targets can be engaged in the minimum time. This entails either drawing on the map itself, or on tracing paper, a combination of degree and range scales in the form of that shown on Plate 30.

The centre of the circle at the bottom is placed at the position of the pivot gun, and the line marked 0° at the top placed along the zero line. A thread is attached to a pin and stuck in the position of the pivot gun.

When the co-ordinates of a target are received they are plotted in the map, and by means of the thread the angle of sight from zero can be read off. The tangent angle is then noted and the angle of sight calculated.

#### Fighting Map - Platoon.





## SECTION 28.—THE T.O.G. METHOD

If voice control methods are not possible and a suitable map does not exist, the T.O.G. method can be used, provided that an observation post can be found from which both the pivot gun and the target can be seen. The distance of the observation post from the gun line is not limited.

The method is deliberate, owing to the distance involved. Unless a telephone is provided, its uses are confined to programme shoots such as barrages, neutralization in support of prearranged attack, etc.

### LESSON 121.—T.O.G.

#### *Instructor's Notes*

#### *Stores :—*

*Plotter, range tables, director, two or more guns with tripods and dial sights, aiming posts.*

#### *Method of instruction :—*

*The situation necessitating the use of T.O.G. and its limitations will be explained. The class will then practise its application outside on the ground.*

#### *1. Explain.*

i. A target with width equal to or less than the gun frontage.

The ranges  $OG_1$  and  $OT_1$  are taken by the range-taker. (Figure 31).

The angle  $T_1OG_1$  is measured with the director.

The angles of sight to  $G_1$  and  $T_1$  are taken.

The angle  $OG_1T_1$  and the range  $G_1T_1$  are obtained from the plotter. (See Lesson 41, A.I. ii).

The angle of sight  $OG_1T_1$  and the elevation are sent by orderly or taken down to the guns, together with orders when to open fire.

#### *At the guns*

The guns are mounted roughly in the direction of the target. On receipt of the angle  $OG_1T_1$  this angle is put on the dial sight of the pivot gun, which is then laid on the director as taught in Lesson 79.

The pivot gun is then used to put the remaining guns on parallel zero lines as in the post method.

To switch to a new target (x) and find the angle  $OG_1X$  by means of the field plotter. (See Lesson 115, paragraph 6).

ii. A target wider than the gun frontage.

It will be necessary to determine the angular width of the target from the gun position.

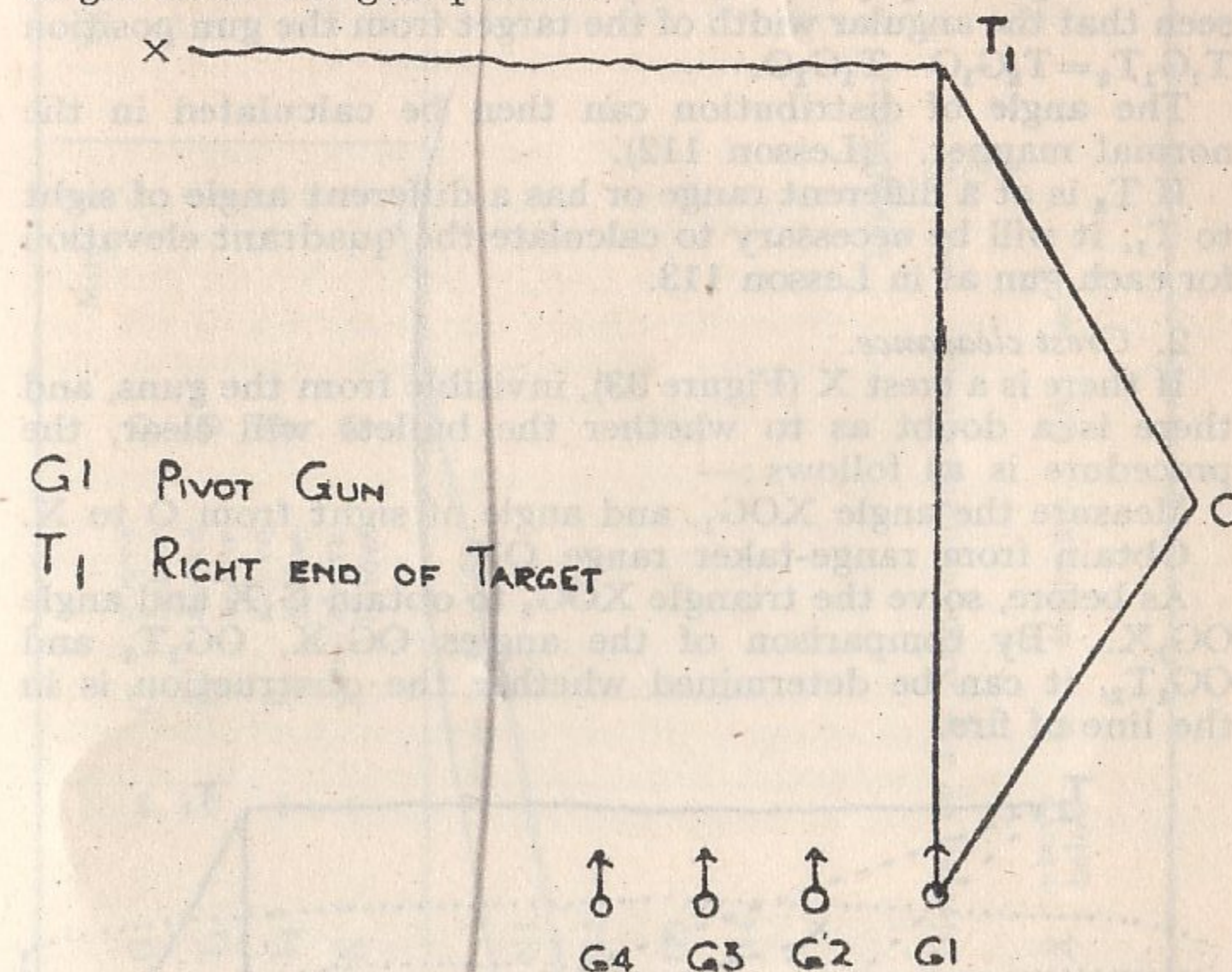


Figure 31

The range-taker takes the range  $OT_2$  (Figure 32) in addition to those taken as in sub-paragraph 1.

The angle  $T_2OG_1$  is measured.

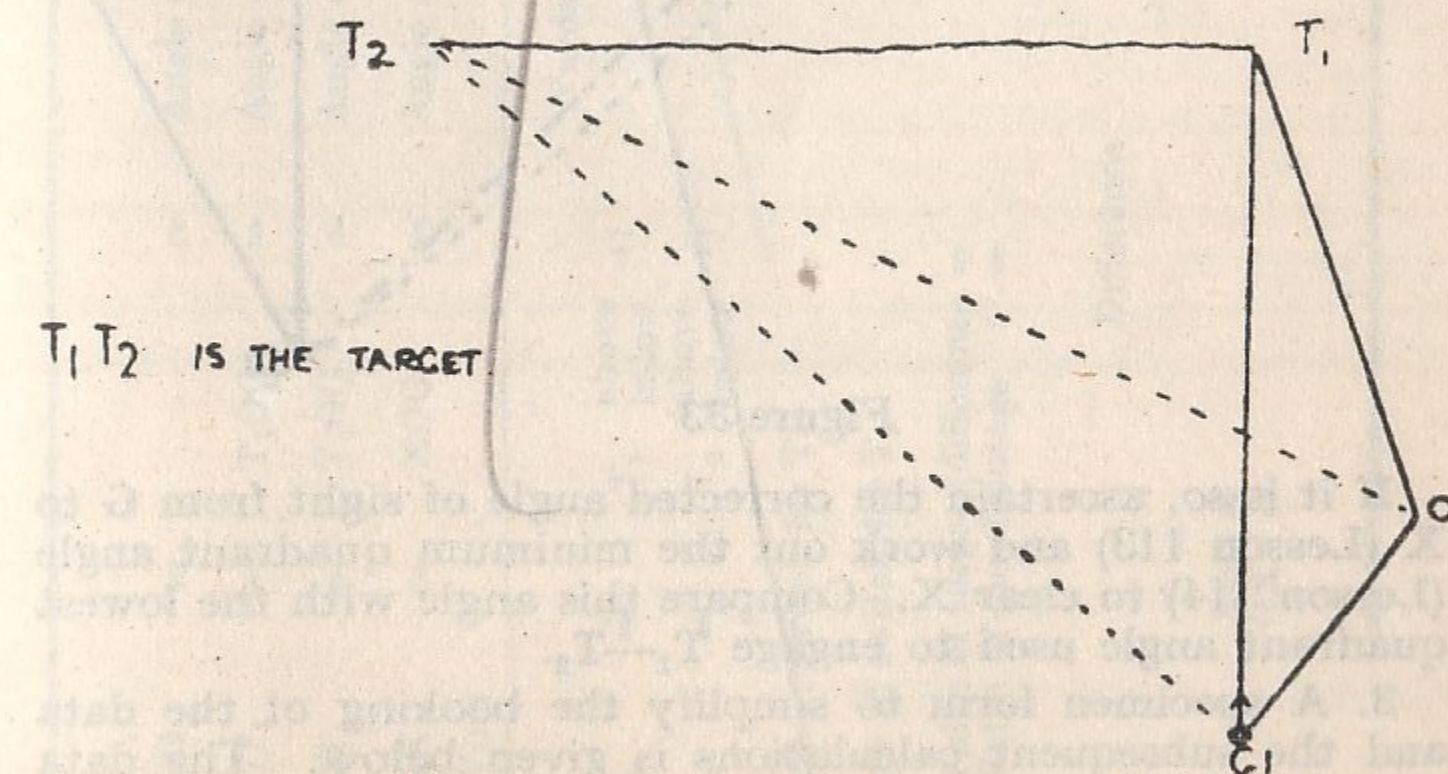


Figure 32



The range  $G_1T_2$  and the angle  $T_2G_1O$  are obtained from the plotter.

The angle  $\text{OG}_1\text{T}_1$  has already been obtained, and it can be seen that the angular width of the target from the gun position  $\text{T}_1\text{G}_1\text{T}_2 = \text{T}_2\text{G}_1\text{O} - \text{T}_1\text{G}_1\text{O}$ .

The angle of distribution can then be calculated in the normal manner. (Lesson 112).

If  $T_2$  is at a different range or has a different angle of sight to  $T_1$ , it will be necessary to calculate the quadrant elevation for each gun as in Lesson 113.

2. *Crest clearance.*

If there is a crest X (Figure 33), invisible from the guns, and there is a doubt as to whether the bullets will clear, the procedure is as follows :—

Measure the angle  $XOG_1$ , and angle of sight from O to X. Obtain from range-taker range OX.

As before, solve the triangle  $XOG_1$  to obtain  $G_1X$  and angle  $OG_1X$ . By comparison of the angles  $OG_1X$ ,  $OG_1T_1$  and  $OG_1T_2$ , it can be determined whether the obstruction is in the line of fire.

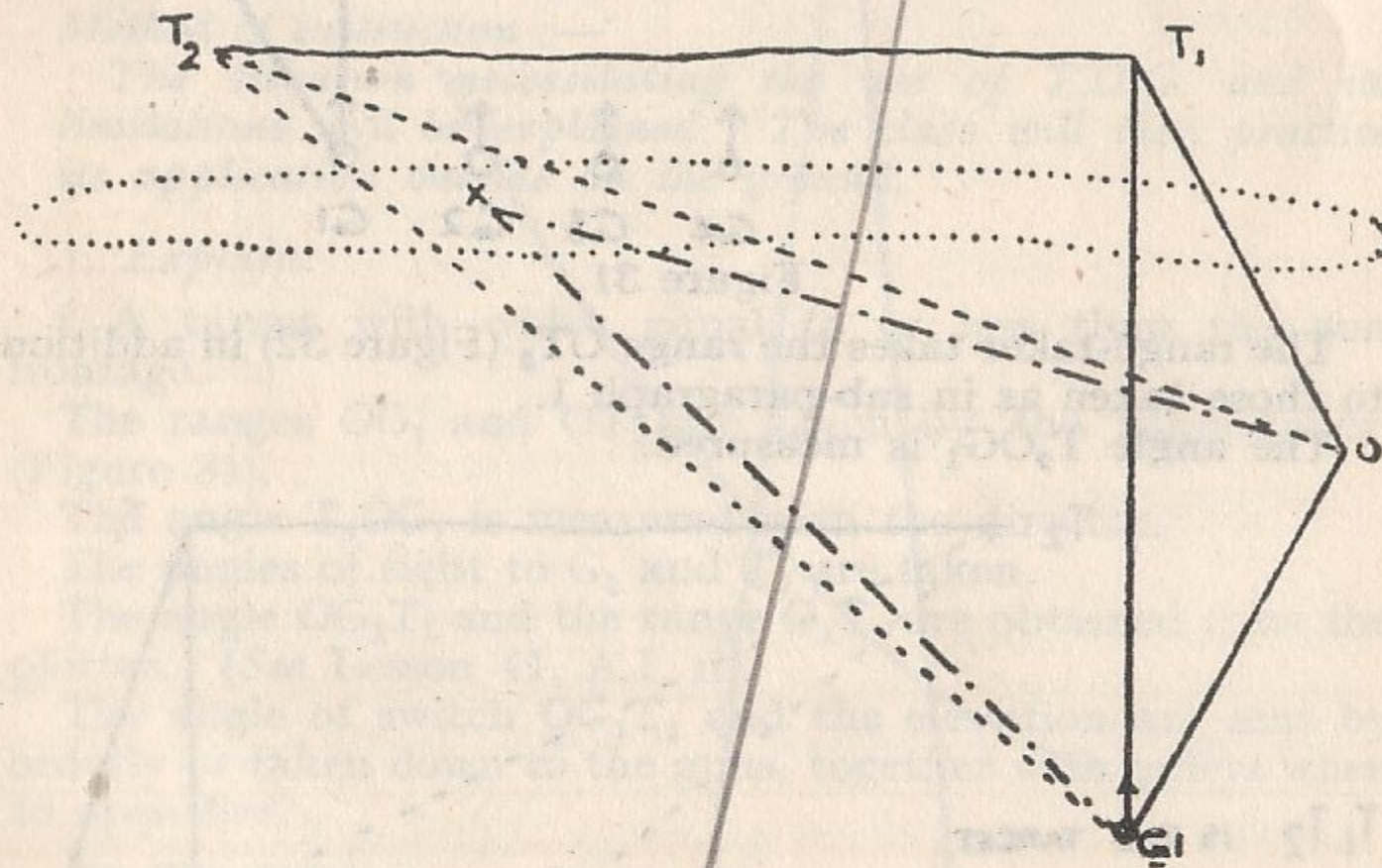


Figure 33

If it is so, ascertain the corrected angle of sight from G to X (Lesson 113) and work out the minimum quadrant angle (Lesson 114) to clear X. Compare this angle with the lowest quadrant angle used to engage T<sub>1</sub>—T<sub>2</sub>.

3. A specimen form to simplify the booking of the data and the subsequent calculations is given below. The data obtained by measurement are underlined. In practice, all data should be obtained before calculation is commenced.

[illegible]



## SECTION 29.—FIRE DIRECTION AND CONTROL CHARTS

1. For the conduct of programme shoots, when fire is required at varying periods on one or more targets, it will generally be preferable to issue charts for the direction and control of fire. Such charts are usually preferable for shooting off the map and for firing by night; for example, in the provision of covering fire for a dawn attack, harassing fire, counter-preparation, barrages, etc.

2. *Fire direction charts* will be prepared by the machine gun company commander, with the object of allotting tasks to individual platoons, or, occasionally, sections. A suitable form is shown on page 87.

Time must be allowed in the programme for the lifts and switches to be put on the guns. At night, a pause of 30 seconds should be allowed for each lift and 60 seconds for each switch. When tapping right and left is required, the time taken to complete the series of bursts and taps should also be allowed for.

In prolonged programmes, pauses should be allowed for the maintenance of the guns. The pauses should be so arranged that never more than one gun at a time is stopped for this purpose.

3. *Fire control charts* are made up by platoon commanders, one for each gun, and are interpreted by a non-commissioned officer at each gun. They are prepared from data obtained from the fire direction chart, if issued, and by measurement.

The chart contains the actual detail of switches, timing and rates of fire, and the elevation and number of taps right and left to be employed for each target. A suitable form is shown on page 88.

When firing indirect by day, it will often be advantageous to prepare a simplified form of chart for use at the guns.

## LESSON 122.—PREPARATION OF CHARTS

### *Instructor's Notes*

#### *Method of instruction :—*

*Officers will be instructed in the preparation of both types of chart, both from detail on the map (indoor work) and from*

*reconnaissances on the ground (outdoor work). Non-commissioned officers will study only the preparation of fire control charts. They will be given a fire direction chart and instructed in compiling the fire control charts—both from detail on the map and on the ground.*

#### 1. *Explain.*

i. Fire control charts will be made out for each gun to save the shouting of orders.

ii. They will be made out by the platoon commander or platoon serjeant from detail obtained from a reconnaissance.

iii. The angle of deviation from zero to any target is the actual deflection from the zero line to bring the gun on to its correct position on that target. With a platoon, it is found by combining the angle of switch from the zero line with the angle of distribution, if any, or its correct multiple (see Fig. 3*h*). With a section, it is formed by combining the angle of switch from the zero line with the angle necessary to bring each gun a quarter of the way in from its own flank of the target. When dealing with targets with width equal to or less than the gun frontage, guns are kept on parallel lines.

iv. Elevation.—Combined sight rule applies.

v. Corrected elevation and/or deviation.—If atmospheric conditions necessitate corrections, these should be made at the last possible moment.

vi. Tapping right and left.

(a) Direct fire.—If the guns are on parallel lines, convert half the gun frontage to minutes, convert to the nearest tap, and add one additional tap for overlap.

e.g.  $\frac{1}{2}$  gun frontage at range to target = 23'

\* \* Taps right and left = 3.

If not on parallel lines, convert one quarter of the width of the target to minutes, convert to the nearest tap, and add one additional tap for overlap.

e.g.  $\frac{1}{4}$  target frontage = 1° 10'

\* \* Taps right and left = 6.

(b) Indirect fire.—As already taught in indirect fire.

vii. Remarks column.—Including time to fire on elevations if lifts are ordered; and ammunition to be expended on each task.



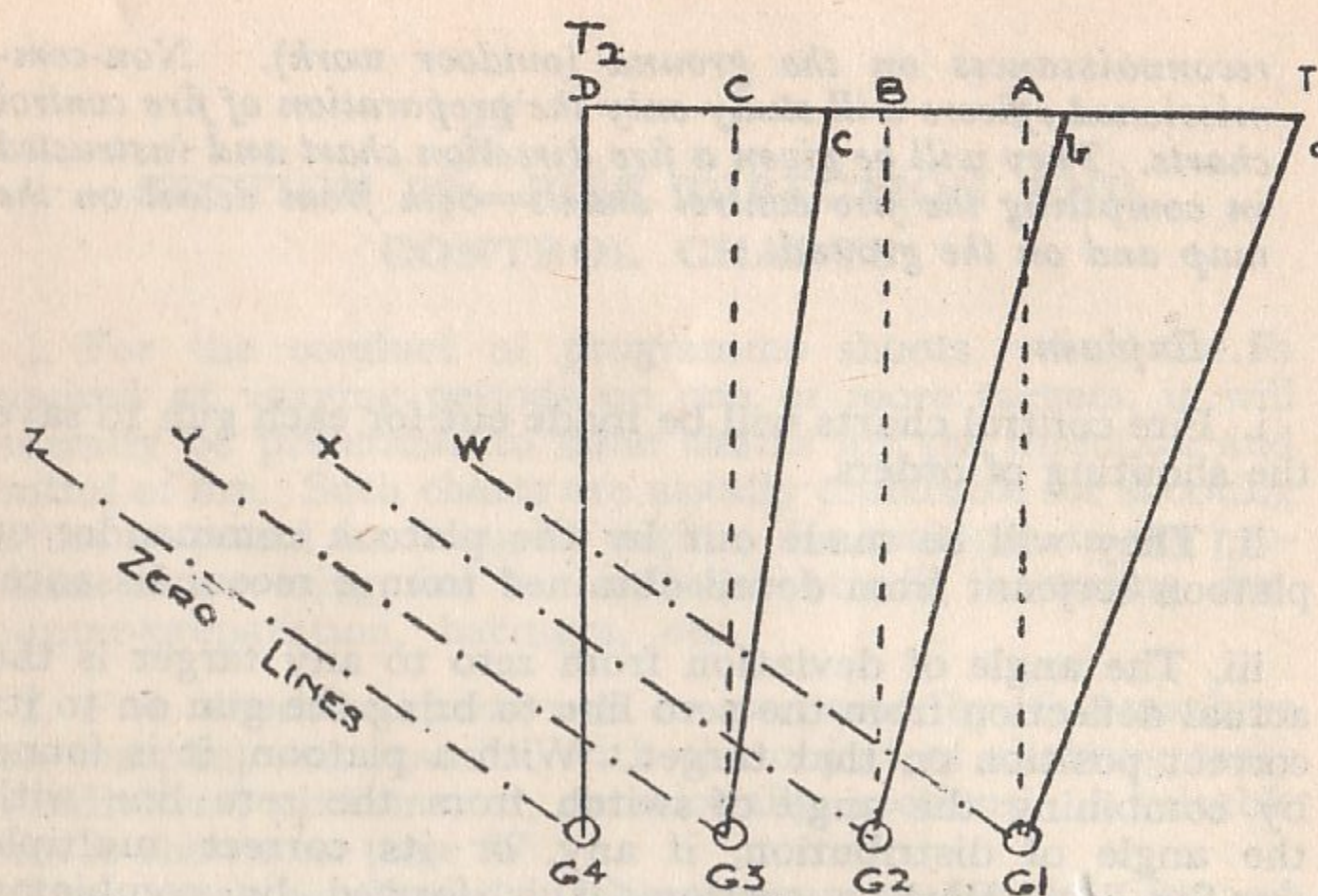


Figure 3

Angle  $ZG_4T_2$  = Angle of switch.

$CG_3C$  = „ distribution.

$cG_3Y$  = „ deviation from zero, Number 3 gun

$bG_2X$  = „ „ „ „ Number 2 gun

$aG_1W$  = „ „ „ „ Number 1 gun

Example I.—Section charts.

NOTE: (a) Number 1 gun pivot gun throughout.

(b) Angles of switch bring Number 1 gun from original zero line to right end of each target unless target is of less width than gun frontage, in which case it will be brought to the centre.

(c) Gun frontage 20 yards.

Number 1 task. (Target wider than gun frontage).

Data obtained

Recorded on chart

Range 1,100 yards.

Elevation—All 1,100 yards.

A. of S. plus 5'

A. of S. plus 5'

Angle of switch from

Pivot gun =  $R.14^\circ$

Angles of deviation—

Width of target =  $4^\circ 40'$

Number 1.  $R.14^\circ - (\frac{1}{4} \text{ of } 4^\circ 40')$

=  $R.14^\circ - 1^\circ 10'$

=  $R.12^\circ 50'$

Number 2.  $R.14^\circ - (\frac{3}{4} \text{ of } 4^\circ 40')$   
plus 20 yards at 1,100 yards.  
=  $R.14^\circ - 3^\circ 30'$  plus  $1^\circ 4'$   
=  $R.11^\circ 34'$   
=  $R.11^\circ 30'$

Taps =  $(\frac{1}{4} \text{ of } 4^\circ 40')$  plus 15' (overlap)  
=  $1^\circ 10'$  plus 15'  
=  $1^\circ 25'$   
= R. & L. 6 Taps.

Number 2 Task. (Oblique target wider than gun frontage).

Amdt. 1  
Mar. 1944

Ranges: R. end 1,700 yds.

Elevation—either.

L. end 1,600 yds.

Number 1.—1,650 yds.

plus 15'.

Angles of sight,

Number 2.—1,650 yds.

$\frac{1}{4}$  way in from R. end of target + 16'

plus 10'.

$\frac{1}{4}$  way in from L. end of target + 8'

Under column headed "Recorded on chart," delete lines 6 to 9 and substitute:—

i.e.  $\frac{1}{4}$  the way in from each end of the target.

Number 1— $2^\circ 35'$ .

Number 2— $2^\circ 30'$ .

All down 100 yards

All up 100 yards

or

All down 10'

All up 15' OR

All down 10' { where 10' is taken  
All up 20' { as a standard lift  
per 50 yards.

Angles of deviation—

Number 1 =  $L.3^\circ$  plus  $(\frac{1}{4} \text{ of } 2^\circ 45')$   
=  $L.3^\circ 41'$   
=  $L.3^\circ 40'$ .

Number 2 =  $L.3^\circ$  plus  $(\frac{3}{4} \text{ of } 2^\circ 45')$   
(20 yds. at 1,650 yds.)  
=  $L.3^\circ$  plus  $2^\circ 4' - 42'$   
=  $L.4^\circ 22'$   
=  $L.4^\circ 20'$ .



$$\begin{aligned}\text{Taps} &= (\tfrac{1}{4} \text{ of } 2^\circ 45') \text{ plus } 15'' \\ &\quad (\text{overlap}) \\ &= 41' \text{ plus } 15' \\ &= 56' \\ &= \text{R. \& L. 4 Taps.}\end{aligned}$$

Number 3 task. (Target of less width than gun frontage.)

*Data obtained.*

*Recorded on chart*

Range 1,600 yards

Elevation—All 1,600 yards

A. of S.—8'

A. of S. —10'

Angle of switch from  
pivot gun L.6° 30'  
(to centre of target)

Lifts —All down 50 yards  
All up 100 yards

Width of target 25'

Angles of deviation—

Number 1 gun=L.6° 30'—  
( $\frac{1}{2}$  20 yards at  
1,600 yards)  
=L.6° 30'—22'  
=L.6° 10'.

Number 2 gun=The same  
L.6° 10'

Taps=( $\frac{1}{2}$  width of gun frontage)  
plus 15' (overlap).

$$= \frac{43'}{2} \text{ plus } 15'$$

$$= 22' \text{ plus } 15'$$

$$= 37'$$

=R. & L. 2 Taps.

Example II.—Platoon chart for Number 4 gun.

*Data obtained*

*Recorded on chart*

Range: 1,950 yards

Elevation: 1,950 yards

A. of S. plus 40'

A. of S.: plus 40'

Angle of switch from  
pivot gun: L.12° 30'

Lifts: All down 50 yards  
All up 100 yards

Width of target: 3° 30'.

Angles of deviation—  
L.12° 30' plus 2° 10'  
(Angle of distribution)  
=14° 40'.

Taps ( $\frac{1}{8}$  of 3° 30')=35'  
=R. & L. 2 Taps.

# FIRE DIRECTION CHART

Unit and Role	Location	Task	Times		Rate of fire. Remarks.
			From	To	
No. 7 Platoon ...	Track junction W. Corner of Robin Hood Ball 544666.	1. N.W. corner New- foundland Farm 5468 to 150x W. along track.	Zero	Z+4.	Rapid.
	Pivot gun laid on right end of Old Farm Clump.	2. South side Old Farm Clump 5468.	Z+6	Z+10	Normal.
	45x Frontage.	3. Junction of tracks 539683 to 150x East.	Z+12	Z+19	Normal.

Signed, F. J. Blank, Capt.,  
Comdg. A Coy.



# FIRE CONTROL CHART

(Data obtained from Example I.)

No. 8 Platoon.

Role.

No. 2 Gun.

Magnetic bearing of zero line. 8°.

N.C.O. i/c. Gun: Sergeant

Angle of switch to corrected zero line.  
(For units equipped with bar foresights.)

Task	Clock		Time		Zero	Time		Angle of deviation from zero	Normal range or Q.A.	Angle of sight	Corrected elevation or deviation	Right and Left Taps	Rate of fire	Remarks
	From	To	From	To	From	From	To							
1	0414	0419	—	—	—	—	—	R. 11° 30'	1,100x	+5'	—	6	Normal	2 belts for task.
2	0430	0433	—	—	—	—	—	L. 4° 20'	2° 30' Down 10' Up 20'	—	—	4	Rapid	2 belts for task. 1 belt on 1st elevation. 1 belt on 2nd and 3rd elevations. Points during firing after this task.
3	—	—	Z	Z+7	Z	Z+7	L. 6° 10'	1600x Down 50x Up 100x	—	—10'	—	2	Normal	3 belts for task. 1 belt on each elevation.

Signed) ..... 2nd Lieutenant,  
Commanding No. 8 Platoon.

Date. 12th December. 1941.

## LESSON 123.—BARRAGES

### Instructor's Notes

Stores :—

Blackboard or sand-table, map (1/25,000 or larger scale), protractor, range tables.

#### 1. Explain

i. When a large number of guns and sufficient ammunition are available, machine guns may be used for barrage fire. Machine gun barrages will usually be required as part of a fire plan which includes the fire of artillery and, possibly, mortars.

Except where the ground is favourable for safety reasons overhead fire must be at least 400 yards ahead of the advancing troops. Unlike artillery support, when the infantry can see the fall of the shells, the infantry have no means of knowing how close they are to a machine gun barrage.

ii. There are two types of barrage :—

(a) Creeping barrages. In which the barrage moves forward in accordance with a prearranged programme at a rate at which the attacking troops can keep up with it. The line on which the barrage opens, and the lifts, are worked out having regard to safety considerations.

(b) Standing barrage. Put down on a definite line and remaining there as long as required or safety considerations permit. Standing barrages may be used either in support of an attack, or, in the form of a box barrage, in order to isolate any area of ground to prevent reinforcement or counter-attack during a raid or small attack operations.

iii. Barrages can be either frontal, oblique, or flanking. The frontal creeping barrage is easier to calculate and control. The flanking barrage may be put down much closer to our own troops than a frontal barrage, but it will seldom be possible to find gun positions which give complete enfilade.

Oblique barrages have the advantages and disadvantages of the frontal and flanking types according to the degree of obliquity.

iv. The intensity of a barrage depends on the range, and the slope of the ground in relation to the angle of descent of



the bullet. As a rough guide, for a frontal barrage, at least one gun per 30 yards of front will be needed.

v. Standing flanking barrages should consist of two parallel lines of fire about 60 yards apart.

vi. The preparations for a barrage sheet are similar to those described in Section 29 paragraphs 1-3.

## 2. Practice.

Give examples on the blackboard, map or sand-table of various types of barrages, and discuss the number and siting of guns and the preparation of fire control charts.

## SECTION 29.—EXAMPLES OF INDIRECT FIRE ORDERS

Amdt. 1  
Mar. 1944

1. Point target, or target not wider than gun frontage.

*Range obtained by range-finder: 1,600 yds. Angle of sight: plus 30'. Wind: 30 m.p.h., 6 o'clock. Gun angle method. No. 1 gun pivot gun.*

Fire controller.

Non-commissioned officer in charge of gun position.

"Zero lines".

"No. 4—Left eight seven degrees two owe minutes. No. 3—Left eight four degrees.

No. 2—Left eight two degrees five owe minutes".

Reports: "Guns on zero lines".

"All—One six hundred plus two five minutes".

Reports: "Guns ready to load".

"Load".

"Right and left—One tap".

"Rapid—Fire".

"Stop.

All—Down fifty.

Go on".

"Stop.

All—Up one hundred.

Go on".

2. Target with width.

*Range obtained by range-finder: 1,400 yds. Target width: 6°. Angle of sight: plus 50'. Wind: 20 m.p.h., 1 o'clock. D.A.P. method. No. 1 gun pivot gun.*

Fire controller.

Non-commissioned officer in charge of gun position.

"Zero lines.

All—Left seven eight degrees three owe minutes".

Reports: "Guns on zero lines".

"All—One four hundred plus five five minutes".

Reports: "Guns ready to load".



"Load".

"Distribution :—

No. 1—Nil.

No. 2—Left one degree two owe minutes.

No. 3—Left two degrees five owe minutes.

No. 4—Left four degrees one owe minutes".

"Right and left—Four taps".

"Wind—Right two owe minutes".

"Fire".

3. Oblique target having the same range to each end.

Range obtained by range-finder : 1,750 yds.

Angles of sight :—

$\frac{1}{4}$  way in from right end : plus 30'.

$\frac{1}{4}$  way in from left end : nil.

Angular width of target :  $1^{\circ} 20'$  (same width as gun frontage).

Wind : nil. Post and D.A.P. method. No. 1 gun pivot gun.

Fire controller.

Non-commissioned officer in charge of gun position.

"Zero lines.

All—Left eight two degrees".

Reports : "Guns on zero lines".

"All—One seven fifty.

Nos. 1 and 2—Plus 30'.

Nos. 3 and 4—Nil".

Reports : "Guns ready to load".

"Load".

"Right and left one tap".

"Fire".

"Stop.

All—Down fifty.

Go on".

"Stop.

All—Up one hundred.

Go on".

4. Oblique target with a different range to each end.

Range to right end : 1,550 yds. Range to left end : 1,400 yds. ; both ranges obtained by range-finder.

Angles of sight :—

$\frac{1}{4}$  way in from right end : plus 20 minutes.

$\frac{1}{4}$  way in from left end : minus 10 minutes.

Angular width of target :  $3^{\circ} 10'$ . Wind : 30 m.p.h. 9 o'clock.

Gun angle method.. Number 4 gun pivot gun.

Fire controller.

Non-commissioned officer in charge of gun position.

"Zero lines.

No. 1—Right nine one degrees one owe minutes.

No. 2—Right nine owe degrees.

No. 3—Right eight eight degrees two owe minutes".

Reports : "Guns on zero lines."

"Nos. 1 and 2—One five hundred plus two owe minutes.

Nos. 3 and 4—One four fifty minus one owe minutes"

Or

"Nos. 1 and 2—Two degrees two owe minutes.

Nos. 3 and 4—One degree four five minutes".

Reports : "Guns ready to load".

"Load".

Distribution :—

"No. 4—Nil.

No. 3—Right three owe minutes.

No. 2—Right one degree.

No. 1—Right one degree three owe minutes".

"Right and left two taps".

"Wind—Left one degree".

"Fire".

"Stop.

All—Down fifty (or five minutes). Go on".

"Stop.

All—Up one hundred (or one five minutes). Go on".



## 5. Area target.

Range to near end—1,650 yds. Range to far end—1,750 yds.; both ranges obtained by range-finder.

Angles of sight: Near end—minus 16'.

Far end—plus 8'.

Angular width of target 4 degrees.

Wind—nil.

D.A.P. and post method. No. 1 gun pivot gun.

Fire controller.

Non-commissioned officer in charge of gun position.

"Zero lines.

All—Left five six degrees three owe minutes".

Reports: "Guns on zero lines".

Reports: "Guns ready to load".

"Elevation—All two degrees two five minutes".

"Load".

"Distribution:—

No. 1—Nil.

No. 2—Left five owe minutes.

No. 3—Left one degree four owe minutes.

No. 4—Left two degrees three owe minutes".

"Right and left three taps".

"Fire".

"Stop.

All—Down one five minutes. Go on".

"Stop.

All—Up three owe minutes. Go on".

"Stop.

All—Down four owe minutes. Go on".

"Stop.

All—Up five five minutes. Go on".

Or

"Elevation—All two degrees".

"Distribution—As above".

"Right and left three taps".

"Fire".

"Stop.

All—Up one five minutes. Go on".

"Stop.

All—Up one five minutes. Go on".

"Stop.

All—Up one five minutes. Go on".

"Stop.

All—Up one five minutes. Go on".

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1944



## SECTION 304—EXAMPLES OF INDIRECT FIRE ORDERS

1. Point target, or target not wider than gun frontage. Range obtained by range-finder 1,600 yards. Angle of sight plus 30'. Wind 30 m.p.h. 6 o'clock. Director method.

Fire controller.

Non-commissioned officer in charge of gun position.

Zero lines.

Number 1—Right—Two one degrees one owe minutes.

Number 2 — Right — Nine degrees.

Number 3 — Left — Seven degrees four owe minutes.

Number 4 — Left — One nine degrees.

All—Sixteen hundred plus two five minutes.

Reports "Guns on zero lines."

Reports "Guns ready to load."

Load.

Right and left—One tap.

Rapid fire.

Stop.

All down—fifty.

Go on.

Stop.

All up one hundred.

Go on.

2. Target with width.

Range obtained by range-finder. 1,400 yards. Target width—6°. Angle of sight plus 50'. Wind 20 m.p.h. 1 o'clock. Post method. Number 1 Gun.—Pivot gun.

Fire controller.

Non-commissioned officer in charge of gun position.

Zero lines.

Number 4—Left—Eight seven degrees two owe minutes.

Number 3—Left—Eight four degrees.

Number 2—Left—Eight two degrees five owe minutes.

Reports "Guns on zero lines."

Reports "Guns ready to load."

All—Fourteen hundred plus five five minutes.



**Load.****Distribution.**

Number 1—Nil.

Number 2—Left—One degree two owe minutes.

Number 3—Left—Two degrees five owe minutes.

Number 4—Left—Four degrees one owe minutes.

Right and Left—Four taps.

Wind—Right two owe minutes.

**Fire.**

3. Oblique target having the same range to each end, by range-finder. Range 1,750 yards. Angle of sight to right end plus 30', to left end nil.

Angular width 1° (less than gun frontage).

Wind—nil.

Director method.

Fire controller.

**Zero lines.**

Number 1 — Right — Two two degrees one owe minutes.

Number 2 — Right — One owe degrees.

Number 3—Left—Six degrees four owe minutes.

Number 4—Left—One eight degrees.

All—Seventeen fifty.

Number 1—Plus three owe minutes.

Number 2—Plus two owe minutes.

Number 3 — Plus one owe minutes.

Number 4—Nil.

**Load.**

Right and Left one tap.

Rapid fire.

Stop.

All down fifty.

Go on.

Stop.

All up one hundred.

Go on.

Non-commissioned officer in charge of gun position.

Reports "Guns on zero lines."

Reports "Guns ready to load."

4. Oblique target, range to right end 1,550 yards, range to left end 1,400 yards, both by range-finder.

Angle of sight to right end plus 20', and to left end minus 10'.

Target width 3° 10'.

Wind 30 m.p.h. at 9 o'clock.

D.A.P. and post method. Number 1 Gun—Pivot gun.

Fire controller.

Non-commissioned officer in charge of gun position.

Zero lines.

All—Left eight seven degrees two owe minutes.

Reports "Guns on zero lines."

Number 1—Fifteen fifty plus two owe minutes.

Number 2—Fifteen hundred plus one owe minutes.

Number 3—Fourteen fifty nil.

Number 4—Fourteen hundred minus one owe minutes.

Reports "Guns ready to load."

**Load.****Distribution.**

Number 1—Nil.

Number 2—Left three owe minutes.

Number 3—Left—One degree.

Number 4 — Left — One degree three owe minutes.

Right and Left two taps.

Wind—Left—One degree.

Fire.

Stop.

All down fifty.

Go on.

Stop.

All up one hundred.

Go on.

5. Oblique target.

Range to right end 1,450, to left end 1,350, both by range-finder.

Angle of sight to right end plus 40' and to left end plus 10'.



Angular width  $1^{\circ} 30'$  (less than gun frontage).

Wind—Nil.

Director method (director in rear).

Fire controller.

Zero lines.

Number 1 — Right — One  
six eight degrees two owe  
minutes.

Number 2 — Right — One  
seven five degrees three  
owe minutes.

Number 3 — Left — One  
seven seven degrees.

Number 4 — Left — One  
seven owe degrees one owe  
minutes.

Number 1 — Fourteen fifty  
plus four owe minutes.

Number 2 — Fourteen hun-  
dred plus three owe min-  
utes.

Number 3 — Fourteen hun-  
dred plus two owe min-  
utes.

Number 4 — Thirteen fifty  
plus one owe minutes.

Load.

Right and Left—One tap.

Rapid fire.

NOTE.—An alternative method of working out the elevation  
is as follows:—

Elevation.

Number 1 — Two degrees  
three five minutes.

Number 2 — Two degrees  
two owe minutes.

Number 3 — Two degrees  
five minutes.

No. 4 — One degree five  
owe minutes.

6. Area target.

Range to near end 1,650 yards, to far end 1,750 yards, both  
by range-finder

Non-commissioned officer in  
charge of gun position.

Reports "Guns on zero lines."

Reports "Guns ready to load."

Angle of sight to near end plus  $13'$  and to far end plus  $21'$ .

Angular width of target  $4^{\circ}$ .

Wind—Nil

Director method.

Fire controller.

Zero lines.

Number 1 — Right — One  
nine degree two owe min-  
utes.

Number 2 — Right — Seven  
degrees three owe minutes.

Number 3 — Left — Seven  
degrees.

Number 4 — Left — One  
eight degrees two owe  
minutes.

Elevation—All two degrees  
four five minutes.

Load.

Distribution.

Number 1—Nil.

Number 2 — Left — Five  
owe minutes.

Number 3 — Left — One  
degree four owe minutes.

Number 4 — Left — Two  
degrees three owe min-  
utes.

Right and Left three taps.

Fire.

Stop.

All down one owe minutes.

Go on.

Stop.

All up two owe minutes.

Go on.

Stop.

All down three owe minutes.

Go on.

Stop.

All up four owe minutes.

Go on.

Or

Elevation—All two degrees  
two five minutes.

Non-commissioned officer in  
charge of gun position.

Reports "Guns on zero lines."

Reports "Guns ready to load."



Load.  
 Distribution.  
 Number 1—Nil.  
 Number 2 — Left — Five  
 owe minutes.  
 Number 3 — Left — One  
 degree four owe minutes.  
 Number 4 — Left — two  
 degrees three owe minutes.  
 Right and Left three taps.  
 Fire.  
 Stop.  
 All up one five minutes.  
 Go on.  
 Stop.  
 All up one five minutes.  
 Go on.  
 Stop.  
 All up one five minutes.  
 Go on.

### SECTION 30.—FLANKING AND OVERHEAD FIRE

1. The provision of supporting fire to our own troops is the main tactical role of the machine gun. The safety of the troops to whom such support is being given must be the first consideration of the machine gun commander.

2. Supporting fire can be provided either from the flank of a line of advance or defended locality, or by overhead fire; that is, when the trajectory passes over the heads of our own troops. Where possible, flanking fire positions should be sought; not only because of the greater fire effect generally obtained from the beaten zone in enfilade, but also because fire from a flank can be put down with safety considerably closer to the troops being supported than can overhead fire. Before the occupation of a position for the purpose of overhead fire it is necessary to determine that such fire will be safe to our own troops. This increases the time required for the guns to be brought into action.

3. In order that the safety of the troops may be ensured, it is essential that their position or movements should be observed by or known to the fire controller.

In defence, such observation or knowledge should not present any serious difficulty. In attack, the possibility of observing the movements of our own troops will depend on various factors, .g. the nature of the ground (whether open, close, flat or hilly), obstructions to the field of view, bad visibility, smoke screen, etc. Since such observations can hardly be assured, it is evident that considerable caution will have to be exercised.

4. Apart from the above considerations, the machine gun, by reason of its stable mounting and the close grouping of its fire, is well suited to carry out flanking and overhead fire with safety to our own troops.

5. Flanking and overhead fire are governed by definite rules, which are contained in the following sections.

These rules take into account unarmoured troops in the open. If our own troops are dug in, common sense will indicate to what extent the rules may be relaxed. For instance, it may be safe to fire just over the top of a deep trench 200 yards in front of the gun, but at longer ranges the risk of dropping bullets at a steep angle of descent into our own trenches must not be taken.

Tanks are immune from machine gun fire, and fire may be put down close ahead of, or even among, friendly tanks.



6. In solving any problem in connection with the safety of our own troops, the worst possible situation must be taken as a basis for applying the rule.

7. On occasions it may be unsafe to engage a target if the fire control rules are complied with. It may, however, be possible to fire on the target by modifying the fire control rules, by reducing the number either of taps or of elevations.

## LESSON 124.—FLANKING FIRE

### *Instructor's Notes*

*Stores :—*

*Blackboard, slide rule, and field glasses.*

*Method of instruction :—*

*The application of the rules will be explained on the blackboard and the class will then practise on the ground.*

1. *Explain*—the following are the rules for flanking fire :—  
The diagrams referred to in Plate 31 illustrate examples in defence and attack.

i. Barrels must not point, nor bullets fall, within three degrees of our own troops.

Attack : GB is the line of fire to engage a target. If our own troops are advancing in the direction shown, as soon as they reach the line GC, fire must cease.

Defence : A represents the flank of our own troops and GB the line of fire. For safety, the angle AGB must be three degrees or greater.

The lateral allowance of three degrees covers :—

- (a) Minor inaccuracies in aiming, tapping, and in estimation of the strength of side winds.
- (b) Movement of the tripod settling in during the first burst of fire, etc.
- (c) Half the width of the beaten zone.

ii. The three degrees limit extends to a point 300 yards beyond the place where the top bullet of the gun on the highest elevation is expected to fall.

To obtain this point : add 300 yards and half the beaten zone at the highest elevation.

e.g. Range to target 1,500 yards (by range finder).

Combined sight rule calls for  $3^\circ$  elevation.

\* \* \* highest elevation = 1,550 yards.

Length of beaten zone at 1,550 yards = 100 yards.

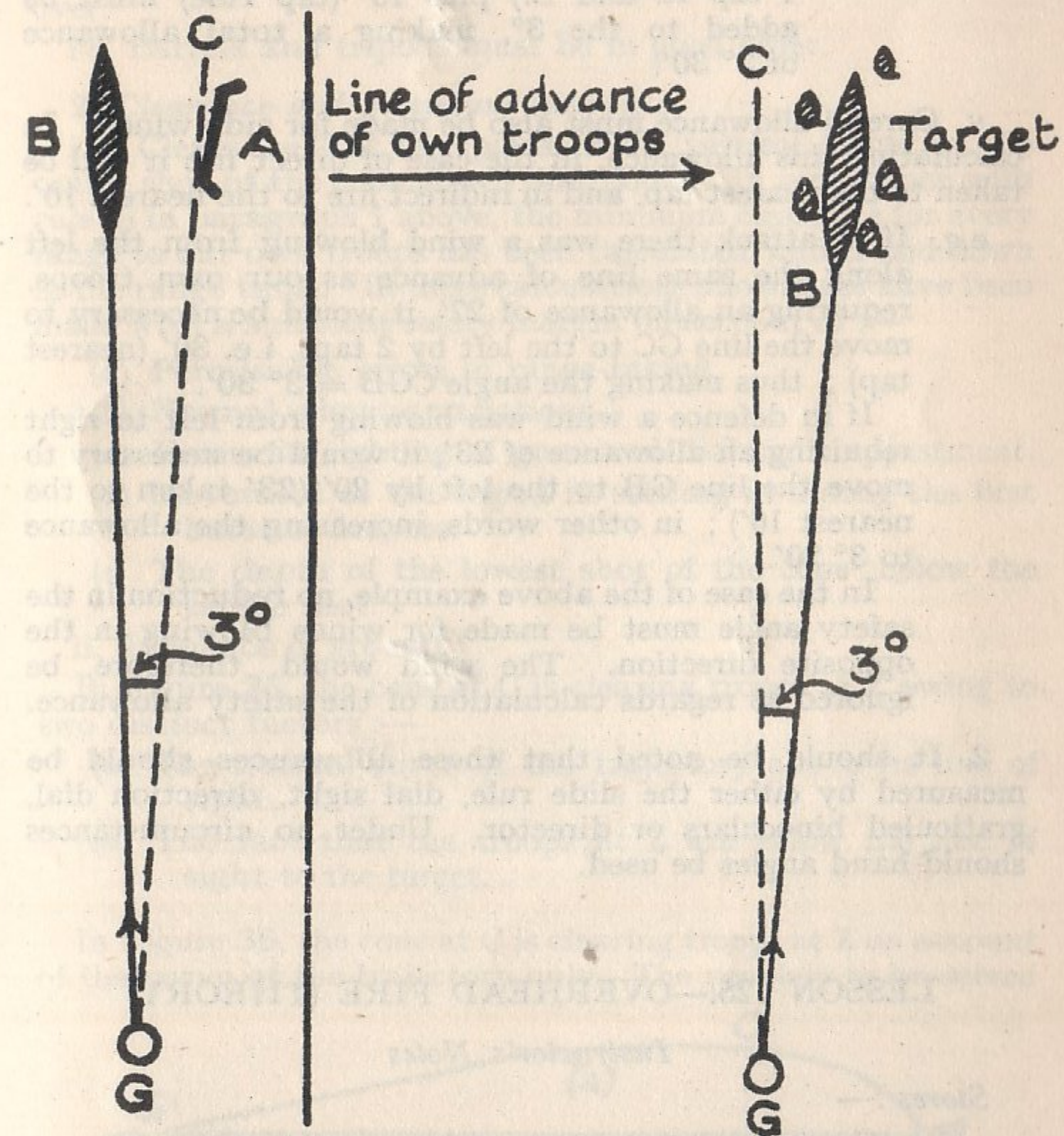
\* \* \* Distance of point to which  $3^\circ$  limit extends.

= 1,550 yards plus 50 yards plus 300 yards = 1,900 yards.

iii. This type of fire must not be attempted if the position of our own troops in the vicinity of the danger area is unknown.

As already pointed out, this rule entails either observation of our own troops or a timed programme, based on a rate of advance which must not be exceeded by the infantry companies concerned.

## PLATE 31 Flanking Fire



Defence.

Defence.

A is a rifle locality.  
B is a fixed line to it.  
G is the gun line.

Attack.

Attack.

B is the target.  
G is the gun line.



iv. Arrangements must be made to prevent tapping inside the three degrees limit. This entails considering the number of taps required by the tap rule and any width that the target may have.

e.g. Target 30' wide.

Range to target = 1,000 yards.

\* \* an allowance of 15' (width of target covered by 1 tap R. and L.) plus 15' (tap rule) must be added to the 3°, making a total allowance of 3° 30'.

v. Careful allowance must also be made for side winds. In calculating this allowance, in the case of direct fire it will be taken to the nearest tap, and in indirect fire to the nearest 10'.

e.g. If in attack there was a wind blowing from the left along the same line of advance as our own troops, requiring an allowance of 27', it would be necessary to move the line GC to the left by 2 taps, i.e. 30' (nearest tap); thus making the angle CGB = 3° 30'.

If in defence a wind was blowing from left to right requiring an allowance of 23', it would be necessary to move the line GB to the left by 20' (23' taken to the nearest 10'); in other words, increasing the allowance to 3° 20'.

In the case of the above example, no reduction in the safety angle must be made for winds blowing in the opposite direction. The wind would, therefore, be ignored as regards calculation of the safety allowance.

2. It should be noted that these allowances should be measured by either the slide rule, dial sight, direction dial, graticuled binoculars or director. Under no circumstances should hand angles be used.

## LESSON 125.—OVERHEAD FIRE (THEORY)

### *Instructor's Notes*

*Stores :—*

*Blackboard, slide rule, range table and field glasses.*

*Method of instruction :—*

*The theory contained in this Lesson will be explained and the class will work out simple problems on the safety angle. It will be made clear that these problems are in practice solved on the slide rule. (Lesson 126.)*

## 1. Explain

### *Rules for overhead fire.*

i. Ranges to *our own troops* must be taken by range-finder, or from a map of not less scale than 1/5,000.

ii. Fire must not be delivered over the heads of our own troops when the range to *those troops* exceeds 3,800 yards.

iii. It must be ensured that the bullets pass at a certain minimum height above the heads of the troops being fired over.

iv. Barrels and tripods must be in good order.

## 2. Clearance and minimum clearances

i. "Clearance" at any point is the vertical height of the centre shot of the cone above that point. In accordance with rule iii in paragraph 1 above, the minimum clearance for every range to our own troops has been calculated, and is laid down in the range table. In these calculations allowances have been made with a sufficient safety margin on account of :—

- Permissible errors in range-taking.
- Normal climatic variations.
- Errors in sighting of guns and dial sight adjustment.
- Movement of the tripod in settling in during the first burst of fire, etc.
- The depth of the lowest shot of the cone below the centre shot.

ii. Influence of ground.

In Figure 35, the cone at C is clearing troops at Z owing to two distinct factors :—

- The natural curve of the trajectory above its line of sight.
- The fact that the troops at Z are below the line of sight to the target.

In Figure 36, the cone at C is clearing troops at Z on account of the curve of the trajectory only. The problem to be solved

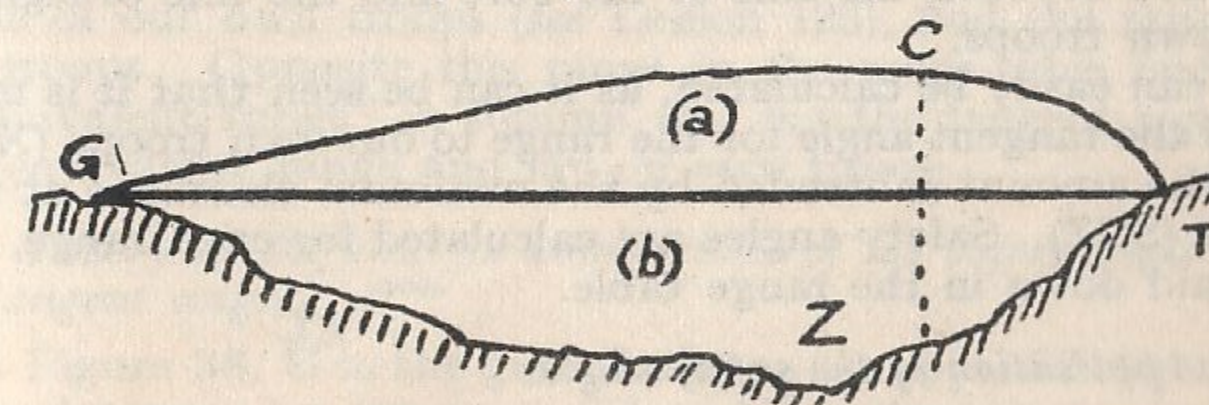


Figure 35



in Figures 35 and 36 before overhead fire can be opened, is whether the cone will clear the point Z by the minimum safety clearance.

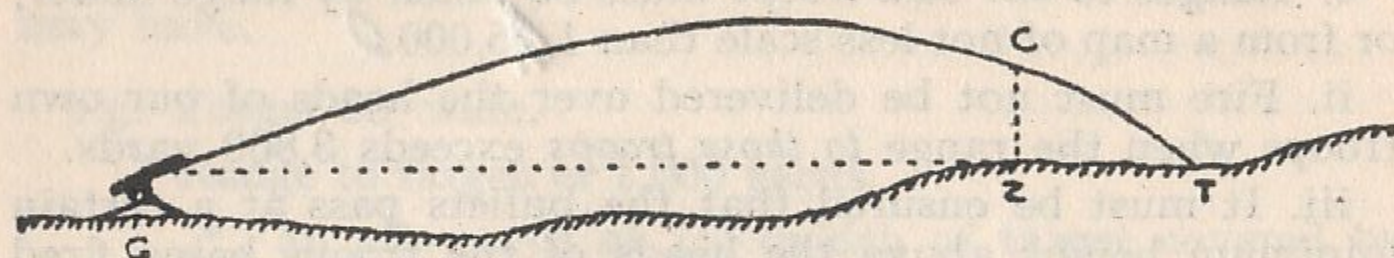


Figure 36

### 3. The safety angle.

The minimum clearance can also be expressed as an angle. Consider Figure 37.

G is the gun.

GX the axis of the bore.

SZ the minimum clearance for our troops at Z.

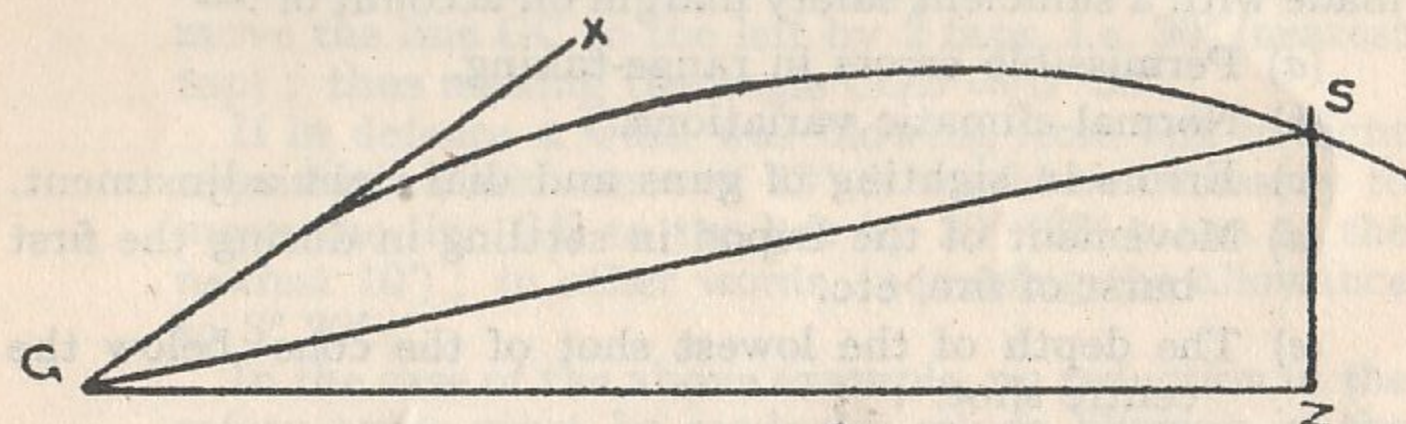


Figure 37

Theoretically, there is only one position of the axis of the bore which will cause the centre shot to pass exactly through S. Suppose GX to be this position; any lower position would cause the trajectory to pass below S, and the necessary minimum clearance would not be given.

The angle XGZ is known as the safety angle for the range GZ, and is defined as the minimum angle which must be included between the axis of the bore and the line of sight to our own troops.

It can easily be calculated, as it can be seen that it is made up of the tangent angle for the range to our own troops (XGS) and the amount subtended by the minimum clearance at that range (SGZ). Safety angles are calculated for each range, and are laid down in the range table.

### 4. Application of the safety angle.

In order to decide whether our troops in a particular position are safe when a target is to be engaged, it is neces-

sary to compare the safety angle for the range to our own troops with the tangent angle for the range to the target. If combined sights are used, the tangent angle for the lowest range must be compared. The procedure is governed by the following rules:—

- If the safety angle required at the range to our own troops is equal to or less than the lowest tangent angle to be employed, our troops are safe.
- If the safety angle required is greater than the tangent angle, our troops are not safe unless they are below the line of sight to the target to the extent of the difference between these two angles.

Example:—

Range by range-finder to target, 1,700 yards.

Range by range-finder to our own troops, 1,400 yards.

Combined sights must be used, therefore work from lowest elevation, i.e. 1,650.

Safety angle required for	...	...	1,400 = 2° 51'
Tangent angle for	...	...	1,650 = 2° 21'
Difference	...	...	= 30'

Therefore our troops must be 30' below the line of sight to the target to be safe.

The angle which our troops must be below the line of sight to the target to be safe can be measured from the gun position by means of the graticules in field-glasses, by any other accurate method of measuring vertical angles, or by the slide rule. This angle is known as the ground angle.

In indirect fire, for our troops to be safe, the safety angle for the range to our troops plus or minus the angle of sight to our troops must be equal to or less than the lowest quadrant elevation used to engage the target.

5. If it is required to fire as closely as possible over the heads of our own troops (see Lesson 128), find the range to our troops. Opposite this range in the range-table find the "Equivalent range" in column 16. Set the tangent sight to this equivalent range and lay on own troops.

### 6. Theory of the rule for comparison of the safety angle with the tangent angle.

In Figure 38, G is the gun; Z our own troops, SZ the minimum clearance for the range GZ and T is the target.

Now if to hit T the axis of the bore were in a position GX



and the centre shot passes through S,  $XGZ$ , the safety angle, is equal to the tangent angle to hit T, and our own troops are safe.

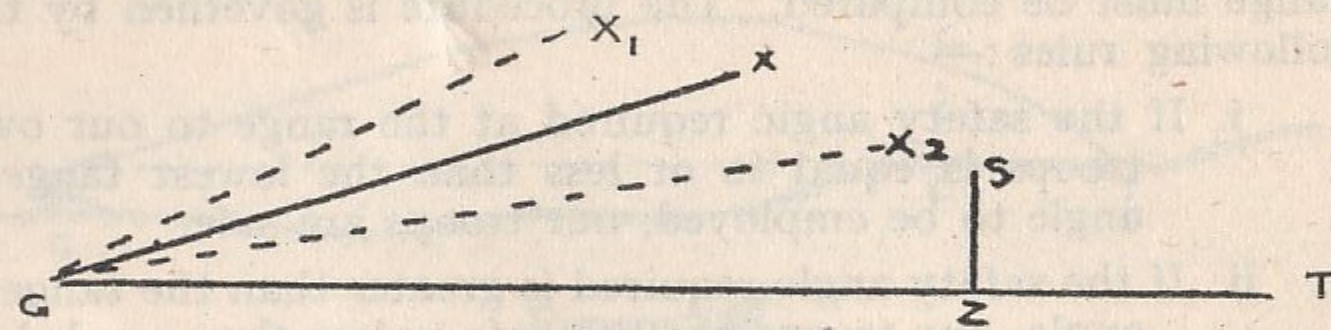


Figure 38

If to hit T, the position of the axis of the bore were in a position  $GX_1$ , the trajectory of the centre shot would pass above S and our troops are safe.

Hence, we get the rule that if the safety angle ( $XGZ$ ) is equal to, or less than, the tangent angle ( $X_1GT$ ) our troops are safe provided they are not above the line of sight to the target.

If, however, to hit T the position of the axis of the bore were  $GX_2$ , the trajectory would pass below S, and our troops at Z are not safe. Here the safety angle ( $XGZ$ ) is greater than the tangent angle ( $X_2GT$ ).

We have only considered the case where our troops are on the line of sight to the target. The ground will often be favourable, and our troops (Z) may be below the line GT.

In Figure 39, the ground is favourable, and our troops, instead of being at Z are at  $Z_1$ ; we can therefore lower the axis of the bore from GX to  $GX_1$ , where  $X_1GZ_1$  is the safety angle for the range  $GZ_1$ , or (GZ) and  $X_1GT$  is the tangent angle to hit T.

Here it can be seen that the safety angle  $X_1GZ_1$  is greater than the tangent angle ( $X_1GT$ ) by the amount the ground has given us ( $ZGZ_1$ ) and our troops are safe. The ground must give us this amount, or our troops would be unsafe.

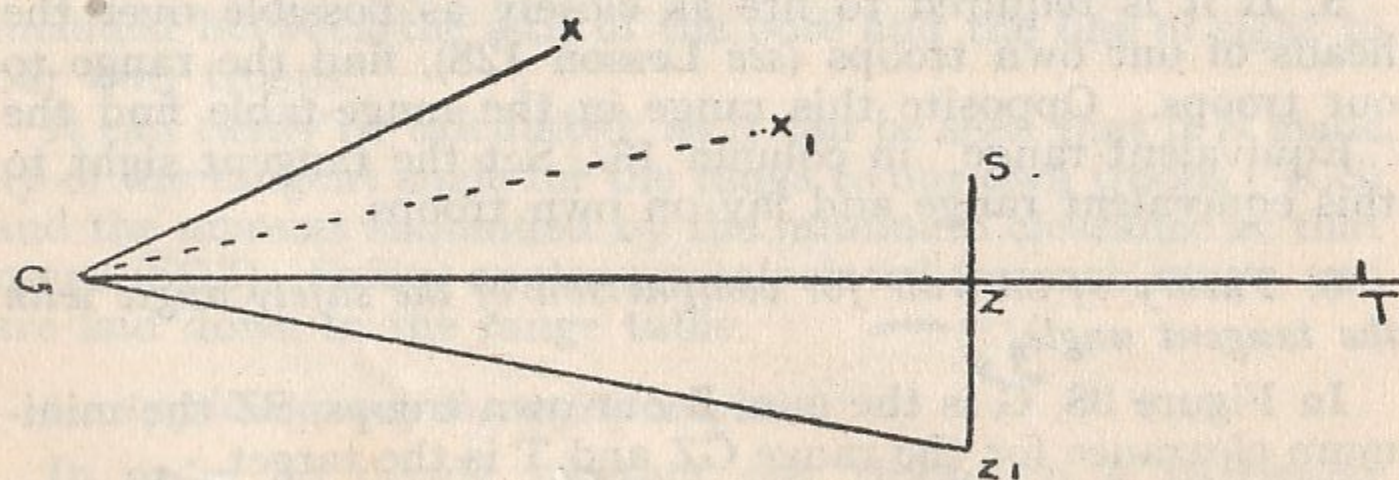


Figure 39

Hence we get the rule that if the safety angle for the range to our own troops is greater than the lowest tangent angle used to engage the target, our troops will be safe if the angle between the line of sight to the target and the line of sight to our own troops is equal to, or greater than, the difference.

#### 7. Safety problems with T.O.G. method.

See Figure 33.

If the point X, instead of being the top of a crest, is the most dangerous position of our own troops, proceed as in Lesson 121 (2), except that the lowest quadrant angle used to engage  $T_1-T_2$  will be compared with the safety angle for the range  $G_1X$  instead of the minimum Q.A. to clear X.

### LESSON 126.—USE OF THE SLIDE RULE IN OVERHEAD FIRE

#### Instructor's Note

Stores:—

Slide rules and field glasses.

Method of instruction:—

The various methods of applying the slide rule will be explained indoors and the class will then practise on the ground. The instructor setting practical problems.

#### 1. Explain.—The purpose of the slide rule.

In order to save the labour entailed in comparing the tangent angles and safety angles, the Machine-Gunner's Slide Rule is provided. (Lesson 40).

To use the slide rule in the case mentioned in the example in Lesson 125, 4 (b), set 1,400 yards on the "Range to Own Troops," scale against 1,650 yards on the "Range to Target" scale. This will cause the slide to project above the top of the rule.

Hold the rule vertically at the full length of the string, bringing the shoulders at the top of the rule Y, in Figure 40, along the line of our own troops nearest the target.

If the target can be seen above the top of the slide X, our troops are safe.

In effect, the height XY subtends at 24 inches from the eye, the amount our troops must be below the line of sight to the target to be safe.

On the right side of the rule will be found a scale on which this amount is indicated when the slide rule is set.



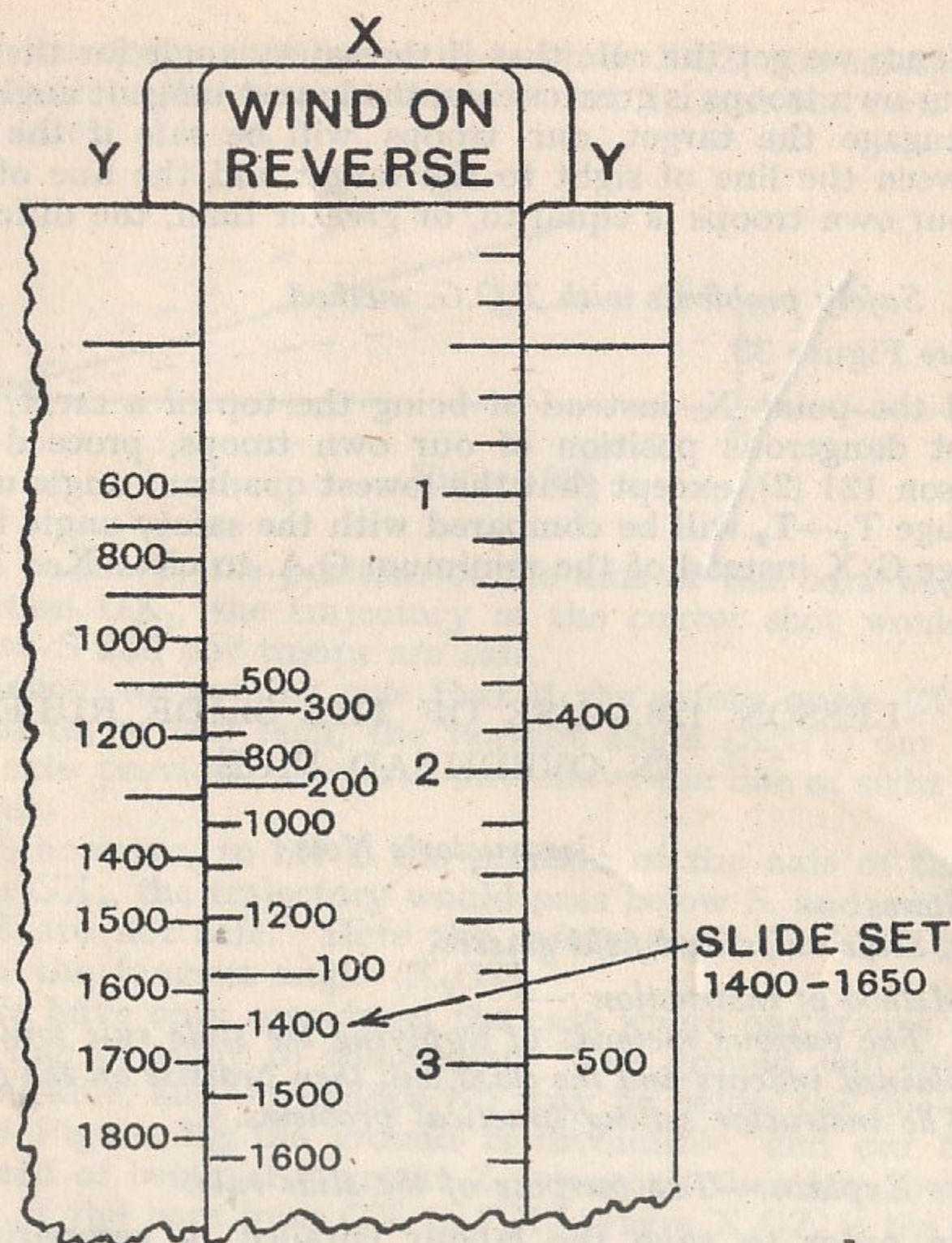


Figure 40

## 2. The practical use of the slide rule.

The slide rule is employed in the following cases:—

i. In the reconnaissance for a position from which to engage a definite target over the heads of our troops who are stationary, to determine whether fire can be opened with safety.

The slide rule is set and used as above.

ii. To determine how near to a target our advancing troops can be supported by overhead fire with safety.

The nearest position of our troops to the target is known as the "far limit of safety" for that particular target.

The problem is solved by trial and error, using the slide rule as follows:—

56 The fire controller picks up a point (B) short of the target T (Figure 41) up to which he estimates our troops could advance with safety. He orders his range-taker to take the range to

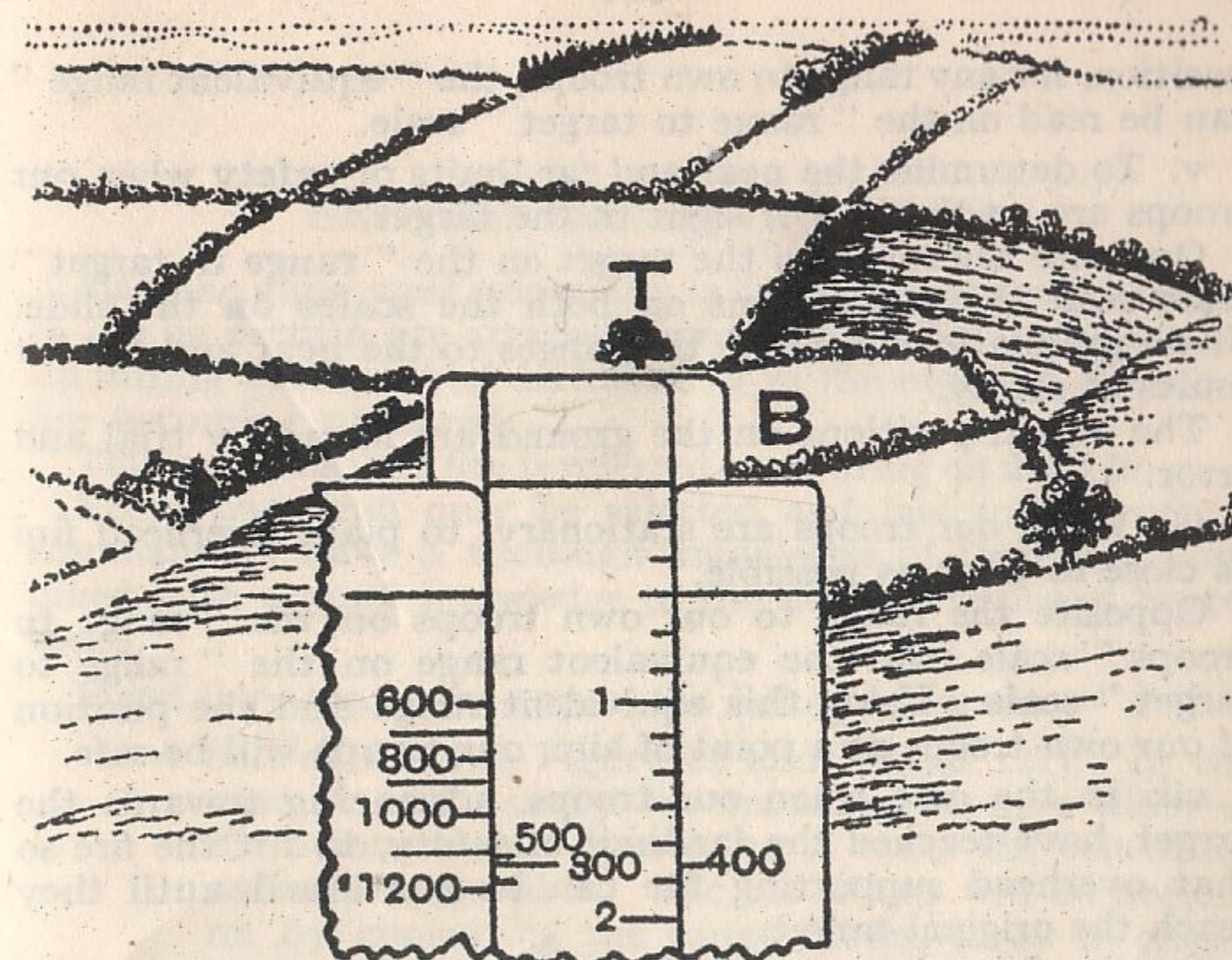


Figure 41

this point and obtains the range to the target. He sets the slide rule as in paragraph 1, above, taking the range to B as the range to our own troops. If the projection XY (Figure 40) does not fit in between the lines of sight B and T, our fire must cease at some point nearer the gun than B. If it fits in with some amount to spare, then fire can be continued until our troops reach some point closer to T.

Another point is then selected for trial either nearer or farther away from B, and the procedure repeated until the far limit of safety is found by a process of elimination.

iii. To determine, when our troops are withdrawing, the line they must clear before fire can be opened on the ground evacuated by them.

Work out the far limit of safety as in ii, above, taking the ground on which fire is eventually required as the target.

iv. To determine, in the case of our troops advancing along the line of fire through the gun position, what line they must clear before fire can be opened.

This position is known as the "near limit of safety" for the particular target concerned.

Using the graduations positioned to the right of the lower ranges on the "range to troops" scale, proceed as in ii, above.

In the following three cases the slide rule is set with the slide flush with the shoulders at the top of the rule. In this



position, for any range to own troops, the "equivalent range" can be read on the "range to target" scale.

v. To determine the near and far limits of safety when our troops are on the line of sight to the target.

Opposite the range to the target on the "range to target" scale read the graduations on both the scales on the slide. These graduations indicate the ranges to the near and the far limits of safety.

The actual positions on the ground are found by trial and error.

vi. When our troops are stationary, to place overhead fire as close to them as possible.

Opposite the range to our own troops on the "range to troops" scale read the equivalent range on the "range to target" scale. Using this equivalent range and the position of our own troops as a point of aim, our troops will be safe.

vii. In the case when our troops, advancing towards the target, have reached the far limit of safety, to lift the fire so that overhead supporting fire can be continued until they reach the original target.

On the "range to troops" scale note the position of the range which has been in use for engaging the target (this must have been obtained by range-finder or 1/25,000 map). Read opposite this the equivalent range on the "range to target" scale. Using this equivalent range on the sight and the target as a point of aim, our troops will be safe when they reach the position of the target.

viii. Whenever observation of strike calls for a range correction, the fire controller must reconsider the safety problem.

### 3. Indirect fire

i. In certain circumstances the slide rule may be used to solve safety problems in indirect fire.

ii. The O.P. must be within 50 yards of the gun position.

iii. If the O.P. is within 12 feet in height from the gun position the slide rule may be used as described above.

iv. If the O.P. is over 12 feet in height above the gun position 5' should be added to the slide rule for each 10 yards that the O.P. is above the guns.

v. Where the O.P. is more than 50 yards from the guns, safety problems should be solved by comparison of angles as described in Lesson 125, in conjunction with Lesson 113.

NOTE.—The figure of 5' mentioned in sub-paragraph iv above is arbitrary, but may be taken as correct for all practical purposes.

## SECTION 32.—FIXED LINES

Machine guns must, especially in defence, make preparations to fire on certain pre-arranged areas should the S.O.S. be sent up during the hours of darkness, or in the event of the arc of fire becoming obscured.

This pre-arranged fire is referred to as firing on fixed lines.

Fixed lines can only be selected and laid intelligently if commanders have a thorough knowledge of their use, combined with a good knowledge of the characteristics of beaten zones.

Fixed lines may take any of the following forms:—

1. A belt of fire (see Figure 42 and Lesson 127). In this case it will usually be necessary to give different elevations to each gun so as to make the belt of fire as long as possible. The elevations will be decided on by consulting the range tables, so as to ensure that the beaten zones will overlap.

On occasions it may be necessary to lay down two belts of fire; e.g. when there are two comparatively important areas at short ranges, which it is desirable should be covered by fixed lines. (See Figure 43.)

2. At times it will be necessary to lay a fixed line on to a bridge, cross-roads, narrow valley or some other place where the enemy is likely to concentrate. Under such circumstances it may be necessary to tap

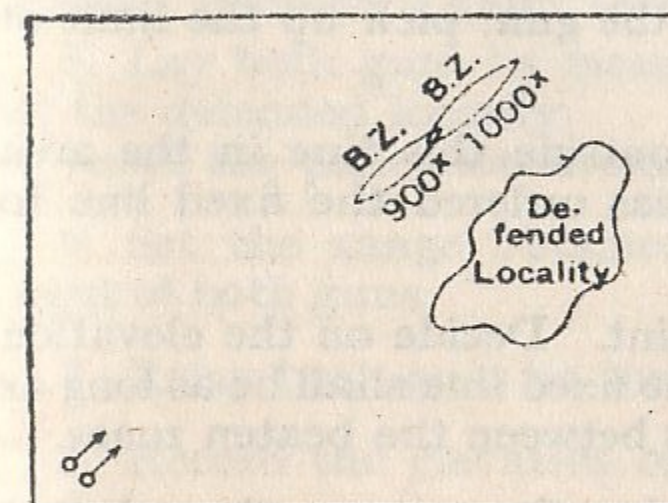


Figure 42

38

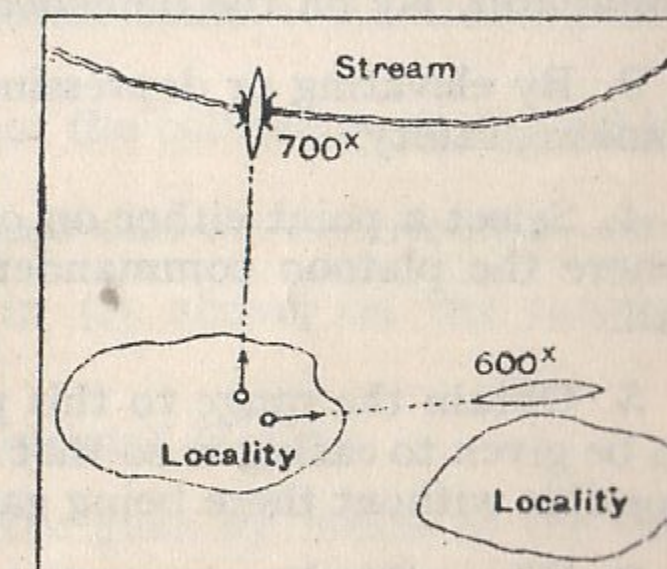


Figure 43

40

Number 1 gun's fixed line is putting down a belt of fire in front of a locality. That of Number 2 is on the Bridge.



right and left in order to cover the whole width of the area to be engaged.

3. There may be occasions when it is desired to place down a mat of fire over the heads of own troops. (See Lesson 128.) In this case the guns are laid and arrangements made to tap right and left so as to form a mat of fire, the width being the amount of frontage with which the guns can satisfactorily deal (e.g. not more than 50 yards per gun).
4. When firing on fixed lines the combined sight rule should not be used.

#### LESSON 127.—LAYING A FIXED LINE (FLANKING FIRE) AS NEAR AS IS SAFE TO A DEFENDED LOCALITY

##### *Instructor's Notes*

##### *Stores :—*

*Gun, tripod, belt, ammunition box, dummy cartridges, dial sight, aiming post.*

##### *Explain and demonstrate*

1. Calculate the safety allowance required, e.g. 3 degrees plus any necessary addition for side wind. This addition must be frequently checked to keep up to date with changes in the strength and direction of the wind.
2. Set this angle on the deflection drum and, using the collimator, lay on the defended locality.
3. By elevating or depressing the gun, pick up the limit of flanking safety.
4. Select a point either on or outside this line in the area where the platoon commander has ordered the fixed line to fall.
5. Obtain the range to this point. Decide on the elevation to be given to each gun so that the fixed line shall be as long as possible without there being gaps between the beaten zones.
6. When this has been done, lay the gun on the selected point with the necessary range on the tangent sight.
7. Reset the deflection drum, and dial on the tripod at zero.  
The gun is now laid on its fixed line,

8. Record the elevation now on the gun, by means of the dial sight.

9. Put out the aiming post and align the collimator on it. Using the deflection drum, record the angle measured and leave it on the instrument.

10. Half load and press the thumbpiece.

NOTE.—When laying the above type of fixed line neither gun will tap right or left.

#### LESSON 128.—LAYING A FIXED LINE (OVERHEAD FIRE) AS NEAR AS IS SAFE TO A DEFENDED LOCALITY; EACH GUN COVERING 50 YARDS OF FRONT

##### *Instructor's Notes*

##### *Stores :—*

*As for Lesson 127, and in addition, slide rule and range table.*

##### *Explain and demonstrate*

1. Obtain the range by range-finder to the defended locality.
2. From the slide rule or range table ascertain the minimum range which will ensure the safety of the troops in the defended locality (i.e. the equivalent range).
3. Convert 25 yards to an angle at the latter range.
4. Set this angle on the deflection drum of Number 1 gun—Right. Number 2 gun—Left.
5. Lay both guns by means of the collimator on the centre of the defended locality.  
Reset the deflection drums and dial on the tripod at zero.
6. Set the range obtained in (2) above, on the tangent sight of both guns.
7. Relay both guns on the defended locality.
8. Record the elevation on the guns by means of the dial sight.
9. Put out the aiming post and align the collimators on it. Using the deflection drum, record the angle measured and leave it on the instrument.
10. Half load and press the thumbpiece.



11. Determine the number of taps required for each gun to cover 25 yards right and left at the range obtained in (2), above.

NOTE.—No lifts will be given.

It may be necessary to consider also flanking safety for one or more defended localities.

# LESSON 129.—LAYING A FIXED LINE WHEN NO DAYLIGHT RECONNAISSANCE HAS BEEN CARRIED OUT

## Instructor's Notes

### Stores :—

As for Lesson 128, and in addition, ~~torches~~, aiming lamp and map.

### Explain and demonstrate

It may sometimes be required to lay a fixed line to protect a locality when no daylight reconnaissance has been possible. This may be carried out in the following manner :—

### Method :—

1. A light will be shown in the locality to be protected from a position nearest to the enemy.
2. Obtain the range to the light by range-finder.
3. Lay the gun, using the tangent sight set at this range, on the light.
4. Set the deflection drum of the dial sight at the necessary safety-angle and tap the gun over until the collimator is laid on the light.
5. Set the range on the range drum of the dial sight and level the bubble by means of the angle of sight drum.
6. Set up the night aiming lamp, measure and record the angle from the fixed line to the aiming lamp, and align the collimator on it.
7. Half load and press the thumbpiece.

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